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Industrial Source Complex (ISC) Dispersion Model User's Guide. Volume I

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INDUSTRIAL SOURCE COMPLEX (ISC) DISPERSION MODEL USER'S GUIDE

VOLUME I

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same basic dispersion-model assumptions. Additionally, both the ISCST and ISCLT programs use either a polar or a Cartesian receptor grid. The ISC Model programs are written in Fortran IV and require approximately 65,000 UNIVAC 1110 computer words. The two programs may also be used on medium-to-large IBM or CDC computer systems with little or no modification. Although the number of sources and receptors that can be included in a single program run varies, each program accepts at least 100 sources and 400 receptors.

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(VOLUME I)

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INDUSTRIAL SOURCE COMPLEX MODEL

VOLUME I

This two-volume report and the related computer programs will be available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 in April, 1980.

Comments and suggestions regarding this publication should be sent to:

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TABLE OF CONTENTS

VOLUME I

Section	Title	Page
	ACKNOWLEDGEMENTS	i
	LIST OF TABLES	v
	LIST OF FIGURES	vii
1	MODEL OVERVIEW	1-1
	1.1 Background and Purpose	1-1
	1.2 General Description	1-2
	1.3 System Description	1-5
	1.3.1 The ISC Short-Term (ISCST) Model Program	1-5
	1.3.2 The ISC Long-Term (ISCLT) Model Program	1-5
	1.4 Summary of Input Data	1-8
	1.4.1 The ISC Short-Term (ISCST) Model Program	1-8
	1.4.2 The ISC Long-Term (ISCLT) Model Program	1-12
2	TECHNICAL DESCRIPTION	2-1
	2.1 General	2-1
	2.2 Model Input Data	2-1
	2.2.1 Meteorological Input Data	2-1
	2.2.2 Source Input Data	2-10
	2.2.3 Receptor Data	2-14
	2.3 Plume Rise Formulas	2-19
	2.4 The ISC Short-Term Dispersion Model Equations	2-24
	2.4.1 Stack Emissions	2-24
	2.4.2 Area, Volume and Line Source Emissions	2-53
	2.4.3 The ISC Short-Term Dry Deposition Model	2-59
	2.5 The ISC Long-Term Dispersion Model Equations	2-62

TABLE OF CONTENTS (Continued)

Section Title Page

2.5.1 Stack Emissions 2-62
2.5.2 Area, Volume and Line Source Emissions 2-68
2.5.3 The ISC Long-Term Dry Deposition Model 2-70

2.6 Example Problem 2-72

2.6.1 Description of a Hypothetical Potash Processing Plant 2-72
2.6.2 Example ISCST Problem 2-72
2.6.3 Example ISCLT Problem 2-77

3 USER'S INSTRUCTIONS FOR THE ISC SHORT-TERM (ISCST) MODEL PROGRAM 3-1

3.1 Summary of Program Options, Data Requirements and Output 3-1

3.1.1 Summary of ISCST Program Options 3-1
3.1.2 Data Input Requirements 3-6
3.1.3 Output Information 3-31

3.2 User's Instructions for the ISCST Program 3-34

3.2.1 Program Description 3-34
3.2.2 Control Language and Data Deck Setup 3-36
3.2.3 Input Data Description 3-41
3.2.4 Program Output Data Description 3-66
3.2.5 Program Run Time, Page and Tape Output Estimates 3-98
3.2.6 Program Diagnostic Messages 3-103
3.2.7 Program Modification for Computers Other than UNIVAC 1100 Series Computers 3-106

4 USER'S INSTRUCTIONS FOR THE ISC LONG-TERM (ISCLT) MODEL PROGRAM 4-1

4.1 Summary of Program Options, Data Requirements and Output 4-1

4.1.1 Summary of ISCLT Program Options 4-1
4.1.2 Data Input Requirements 4-5
4.1.3 Output Information 4-45

4.2 User's Instructions for the ISCLT Program 4-47

4.2.1 Program Description 4-47
4.2.2 Control Language and Data Deck Setup 4-51

TABLE OF CONTENTS (Continued)

Section	Title	Page
	4.2.3 Input Data Description	4-58
	4.2.4 Program Output Data Description	4-85
	4.2.5 Program Run Time, Page and Tape Output Estimates	4-135
	4.2.6 Program Diagnostic Messages	4-140
	4.2.7 Program Modifications for Computers other than UNIVAC 1100 Series Computers	4-145
	REFERENCES	5-1

VOLUME II

Section	Title	Page
	LIST OF TABLES	iii
	LIST OF FIGURES	iv
A	COMPLETE FORTRAN LISTING OF THE INDUSTRIAL SOURCE COMPLEX SHORT-TERM MODEL (ISCST) COMPUTER PROGRAM	A-1
B	COMPLETE FORTRAN LISTING OF THE INDUSTRIAL SOURCE COMPLEX LONG-TERM MODEL (ISCLT) COMPUTER PROGRAM	B-1
C	EXAMPLE EXECUTIONS OF THE ISC SHORT-TERM MODEL (ISCST) COMPUTER PROGRAM	C-1
D	EXAMPLE EXECUTIONS OF THE ISC LONG-TERM MODEL (ISCLT) COMPUTER PROGRAM	D-1
E	CODING FORMS FOR CARD INPUT TO THE ISC SHORT-TERM MODEL (ISCST) COMPUTER PROGRAM	E-1
F	CODING FORMS FOR CARD INPUT TO THE ISC LONG-TERM MODEL (ISCLT) COMPUTER PROGRAM	F-1
G	THE METEOROLOGICAL PREPROCESSOR PROGRAM FOR ISCST	G-1
H	LOGIC FLOW DESCRIPTION OF THE ISC SHORT-TERM MODEL (ISCST) COMPUTER PROGRAM	H-1
I	LOGIC FLOW DESCRIPTION OF THE ISC LONG-TERM MODEL (ISCLT) COMPUTER PROGRAM	I-1

LIST OF TABLES

Number	Title	Page
1-1	Major Features of the ISC Model	1-4
2-1	Hourly Meteorological Inputs Required by the ISC Short-Term Model Program	2-2
2-2	Default Values for the Wind-profile Exponents and Vertical Potential Temperature Gradients	2-2
2-3	Pasquill-Gifford Dispersion Coefficients Used by the ISC Model in the Rural and Urban Modes	2-5
2-4	Meteorological Inputs Required by the ISC Long-Term Model Program	2-6
2-5	Possible Combinations of Wind-Speed and Pasquill Stability Categories and Mean Wind Speeds in Each NCC Star Summary Wind-Speed Category	2-7
2-6	Source Inputs Required by the ISC Model Programs	2-11
2-7	Parameters Used to Calculate σ_y	2-27
2-8	Parameters Used to Calculate σ_z	2-28
2-9	Coefficients Used to Calculate Lateral Virtual Distances	2-32
2-10	Summary of Suggested Procedures for Estimating Initial Lateral Dimensions (σ_{yo}) and Initial Vertical Dimensions (σ_{zo}) for Volume and Line Sources	2-57
2-11	Emissions Data for a Hypothetical Potash Processing Plant	2-74
2-12	Particle-Size Distribution, Gravitational Settling Velocities and Surface Reflection Coefficients for Particulate Emissions from the Ore Pile and Conveyor Belt	2-74
2-13	Emissions Inventory in Form for Input to the ISC Dispersion Model	2-78
2-14	Particulate Emission Rates for the Ore Pile	2-79

LIST OF TABLES (Continued)

Number	Title	Page
2-15	Particulate Emission Rates for the Ore Pile and Conveyor Belt as Functions of Wind Speed and Stability	2-81
2-16	Annual Particulate Emissions for the Ore Pile and Conveyor Belt as Functions of Wind Speed and Stability	2-82
3-1	Meteorological Data Input Options for ISCST	3-2
3-2	Dispersion-Model Options for ISCST	3-2
3-3	ISCST Output Options	3-4
3-4	ISCST Program Card Input Parameters, FORTRAN Edit Code (Format) and Description	3-42
3-5	Julian Day to Month/Season or Month to Season Conversion Chart for Leap Years	3-64
3-6	Time Period Intervals and Corresponding Hours of the Day	3-79
4-1	Meteorological Data Input Options for ISCLT	4-2
4-2	Dispersion-Model Options for ISCLT	4-2
4-3	ISCLT Output Options	4-4
4-4	ISCLT Program Card Input Parameters, FORTRAN Edit Code (Format) and Description	4-59
4-5	Input/Output Tape Format	4-132
4-6	ISCLT Warning and Error Messages	4-141

LIST OF FIGURES

Number	Title	Page
1-1	Schematic diagram of the ISC Model short-term computer program ISCST.	1-6
1-2	Schematic diagram of the ISC Model long-term computer program ISCLT.	1-7
2-1	The sixteen standard 22.5-degree wind-direction sectors used in STAR summaries.	2-9
2-2	Example of a polar receptor grid. The stippled area shows the property of a hypothetical industrial source complex.	2-16
2-3	Example of an irregularly-spaced Cartesian receptor grid. The stippled area shows the property of a hypothetical industrial source complex.	2-18
2-4	The method of multiple plume images used to simulate plume reflection in the ISC Model.	2-42
2-5	Schematic illustration of (a) urban and (b) rural mixing height interpolation procedures.	2-44
2-6	Illustration of plume behavior in complex terrain assumed by the ISC Model.	2-47
2-7	Illustration of vertical concentration profiles for reflection coefficients of 0, 0.5 and 1.0.	2-48
2-8	Relationship between the gravitational settling velocity V_{sn} and the reflection coefficient γ_n suggested by Dumbauld, *et al*. (1976).	2-52
2-9	Representation of an irregularly shaped area source by 11 square area sources.	2-54
2-10	Exact and approximate representations of a line source by multiple volume sources.	2-58
2-11	Plant layout and side view of a hypothetical potash processing plant.	2-73
3-1	Input data deck setup for the ISCST program.	3-40

LIST OF FIGURES (Continued)

Number	Title	Page
3-2	Example input data listing (ISW(6) option).	3-68
3-3	Example listing of a day of meteorological data (ISW(6) option).	3-77
3-4	Example listing of a "daily" average concentration output table (ISW(16) option).	3-80
3-5	Example listing of an "N"-day average concentration output table (ISW(15) option).	3-84
3-6	Example listing of a highest average concentration output table (ISW(17) option).	3-89
3-7	Example listing of a maximum 50 average concentrations output table (ISW(18) option).	3-94
3-8	Example listing of a diagnostic message table printed when source-receptor distances are less than the maximum of 100 meters and three building heights or three building widths.	3-104
3-9	(a) through (e) show the five types of error messages printed by the ISCST Program. The run is terminated after an error message is printed.	3-105
4-1	Input data deck setup for the ISCLT program.	4-57
4-2	Example listing of input data for the calculation of seasonal and annual ground-level particulate concentration from a hypothetical potash processing plant.	4-87
4-3	Example listing of input sources used in the calculation of seasonal and annual ground-level particulate concentration from a hypothetical potash processing plant.	4-102
4-4	Example listing of seasonal ground-level particulate concentration for the winter season due to a single source.	4-114
4-5	Example listing of annual ground-level concentration due to a single source.	4-117

LIST OF FIGURES (Continued)

Number	Title	Page
4-6	Example listing of seasonal ground-level concentration for the fall season due to a single source with a maximum 10 table showing the contribution of this source to the maximum 10 receptors of the indicated combined sources.	4-120
4-7	Example listing of seasonal ground-level concentration for the winter season for combined sources.	4-123
4-8	Example listing of annual ground-level concentration from combined sources.	4-126
4-9	Example listing of the 10 values of seasonal ground-level concentration from a single source that contribute to the maximum 10 receptors of the indicated combined sources for the fall season.	4-129
4-10	Example listing of the 10 values of annual ground-level concentration for a single source that contribute to the maximum 10 receptors of the indicated combined sources.	4-130

SECTION 1

MODEL OVERVIEW

1.1 BACKGROUND AND PURPOSE

In recent years the need has become apparent for a comprehensive set of dispersion model computer programs that can be used to address the complicated air quality impact analysis problems that cannot be adequately handled by the existing, generally available computerized models. Air quality impact analyses for pollutant sources other than emissions from isolated stacks often require consideration of factors such as fugitive emissions, aerodynamic wake effects, gravitational settling and dry deposition. The Industrial Source Complex (ISC) Dispersion Model consists of two computer programs that are designed to consider these and other factors so as to meet the needs of those who must perform complicated dispersion model analyses. The ISC Model computer programs are designed to be flexible, economical and as easy to use as possible without sacrificing the model features required to address complicated problems.

Cautionary Note -- The ISC Model contains a number of options that are designed to consider complicated source configurations and special atmospheric effects. These options include site-specific wind-profile exponents and vertical potential temperature gradients, source-specific plume entrainment coefficients, time-dependent exponential decay of pollutants, stack-tip downwash, building wake effects, plume rise calculated as a function of downwind distance, and dry deposition. If one or more of these options is not specified by the user, the programs will assign preselected default values to various parameters. For regulatory applications, the default values for these options are generally recommended. If the user believes that the use of site-specific or source-specific parameters is appropriate, their use should be discussed with the responsible air pollution control agency prior to the model calculations. Also, because proper application of many of the ISC Model features requires a fundamental knowledge of the concepts of atmospheric transport and dispersion, the user should seek expert advise before using any ISC Model feature that is not fully understood. Finally, because a comprehensive model is required to address complicated problems, the ISC Model is not necessarily the model of choice for all applications. Simpler and less expensive computerized models such as the Single Source (CRSTER) Model (EPA, 1977) should be used for applications that do not require at least one of the ISC Model features.

The ISC Model computer programs are suitable for application to pollutant sources in the following types of studies:

- Stack design studies
- Combustion source permit applications
- Regulatory variance evaluation
- Monitoring network design
- Control strategy evaluation for SIP's
- Fuel (e. g., coal) conversion studies
- Control technology evaluation
- Design of supplementary control systems
- New source review
- Prevention of significant deterioration

1.2 GENERAL DESCRIPTION

The Industrial Source Complex (ISC) Dispersion Model combines and enhances various dispersion model algorithms into a set of two computer programs that can be used to assess the air quality impact of emissions from the wide variety of sources associated with an industrial source complex. For plumes comprised of particulates with appreciable gravitational settling velocities, the ISC Model accounts for the effects on ambient particulate concentrations of gravitational settling and dry deposition. Alternately, the ISC Model can be used to calculate dry deposition. The ISC short-term model (ISCST), an extended version of the Single Source (CRSTER) Model (EPA, 1977), is designed to calculate concentration or deposition values for time periods of 1, 2, 3, 4, 6, 8, 12 and 24 hours. If used with a year of sequential hourly meteorological data, ISCST can also calculate annual concentration or deposition values. The ISC long-term model (ISCLT) is a sector-averaged model that extends and combines basic features of the Air Quality Display Model (AQDM) and the Climatological Dispersion Model (CDM). The long-term model uses statistical wind summaries to calculate seasonal (quarterly) and/or annual ground-level concentration or deposition values. Both ISCST and ISCLT use either a polar or a Cartesian receptor grid. The ISC Model computer programs are written in Fortran IV and require approximately 65,000 UNIVAC 1110 computer words. The major features of the ISC Model are listed in Table 1-1.

The ISC Model programs accept the following source types: stack, area and volume. The volume source option is also used to simulate line sources. The steady-state Gaussian plume equation for a continuous source is used to calculate ground-level concentrations for stack and volume sources. The area source equation in the ISC Model programs is based on the equation for a continuous and finite crosswind line source. The generalized Briggs (1971 and 1975) plume-rise equations, including the momentum terms, are used to calculate plume rise as a function of downwind distance. Procedures suggested by Huber and Snyder (1976) and Huber (1977) are used to evaluate the effects of the aerodynamic wakes and eddies formed by buildings and other structures on plume dispersion. A wind-profile exponent law is used to adjust the observed mean wind speed from the measurement height to the emission height for the plume rise and concentration calculations. Procedures utilized by the Single Source (CRSTER) Model are used to account for variations in terrain height over the receptor grid. The Pasquill-Gifford curves (Turner, 1970) are used to calculate lateral (σ_y) and

TABLE 1-1

MAJOR FEATURES OF THE ISC MODEL

Polar or Cartesian coordinate systems

Plume rise due to momentum and buoyancy as a function of downwind distance for stack emissions (Briggs, 1971 and 1975)

Procedures suggested by Huber and Snyder (1976) and Huber (1977) for evaluating building wake effects

Procedures suggested by Briggs (1973) for evaluating stack-tip downwash

Separation of multiple point sources

Consideration of the effects of gravitational settling and dry deposition on ambient particulate concentrations

Capability of simulating line, volume and area sources

Capability to calculate dry deposition

Variation with height of wind speed (wind-profile exponent law)

Concentration estimates for 1-hour to annual average

Terrain-adjustment procedures for complex terrain

Consideration of time-dependent exponential decay of pollutants vertical (σ_z) plume spread. The ISC Model has rural and urban options. In the Rural Mode, rural mixing heights* and the σ_y and σ_z values for the indicated stability category are used in the calculations. In Urban Mode 1, the stable E and F stability categories are redefined as neutral D stability. In Urban Mode 2, the E and F stability categories are combined and the σ_y and σ_z values for the stability category one step more unstable than the indicated stability category (except A) are used in the calculations (see Section 2.2.1.1). Urban mixing heights* are used in both urban modes.

1.3 SYSTEM DESCRIPTION

1.3.1 The ISC Short-Term (ISCST) Model Program

Figure 1-1 is a schematic diagram of the ISC Model short-term computer program (ISCST). As shown by the figure, ISCST directly accepts the preprocessed meteorological data tape described in the User's Manual for the Single Source (CRSTER) Model and in Appendix G. Alternately, hourly meteorological data may be input by card deck. Program control parameters, source data and receptor data are input by card deck. The program produces printouts of calculated concentration or deposition values.

1.3.2 The ISC Long-Term (ISCLT) Model Program

Figure 1-2 is a schematic diagram of the ISC Model long-term computer program (ISCLT). As shown by the figure, program control parameters, meteorological data, source data and receptor data are input by card deck. The program produces printouts of calculated concentration

---

*The mixing height is the height above the surface at which an elevated stable layer restricts vertical mixing and confines pollutant emissions within the surface mixing layer.

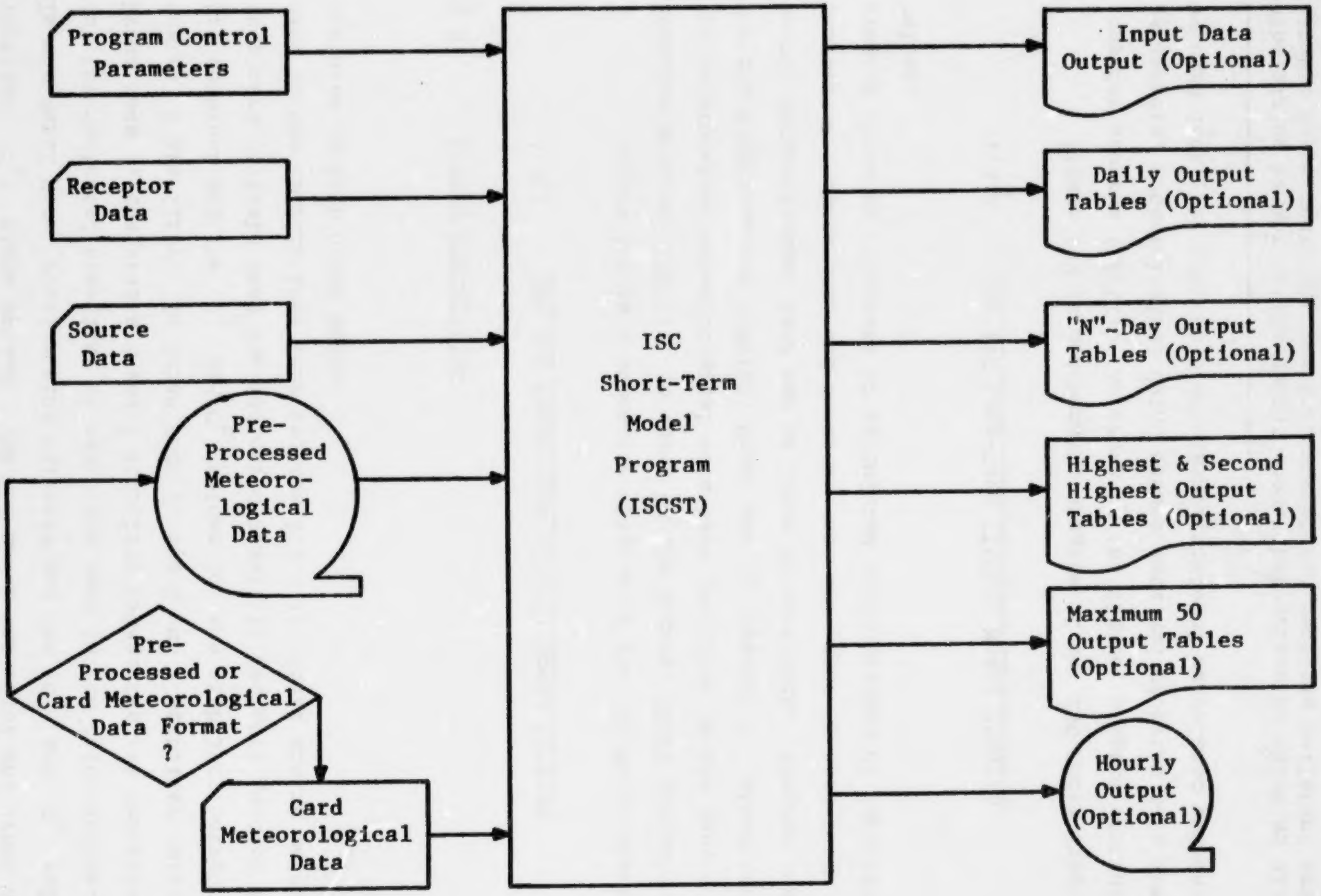
Program Control Parameters
Receptor Data
Source Data
Pre-Processed Meteorological Data
Pre-Processed or Card Meteorological Data Format ?
Card Meteorological Data
ISC Short-Term Model Program (ISCST)
Input Data Output (Optional)
Daily Output Tables (Optional)
"N"-Day Output Tables (Optional)
Highest & Second Highest Output Tables (Optional)
Maximum 50 Output Tables (Optional)
Hourly Output (Optional)

FIGURE 1-1. Schematic diagram of the ISC Model short-term computer program ISCST.

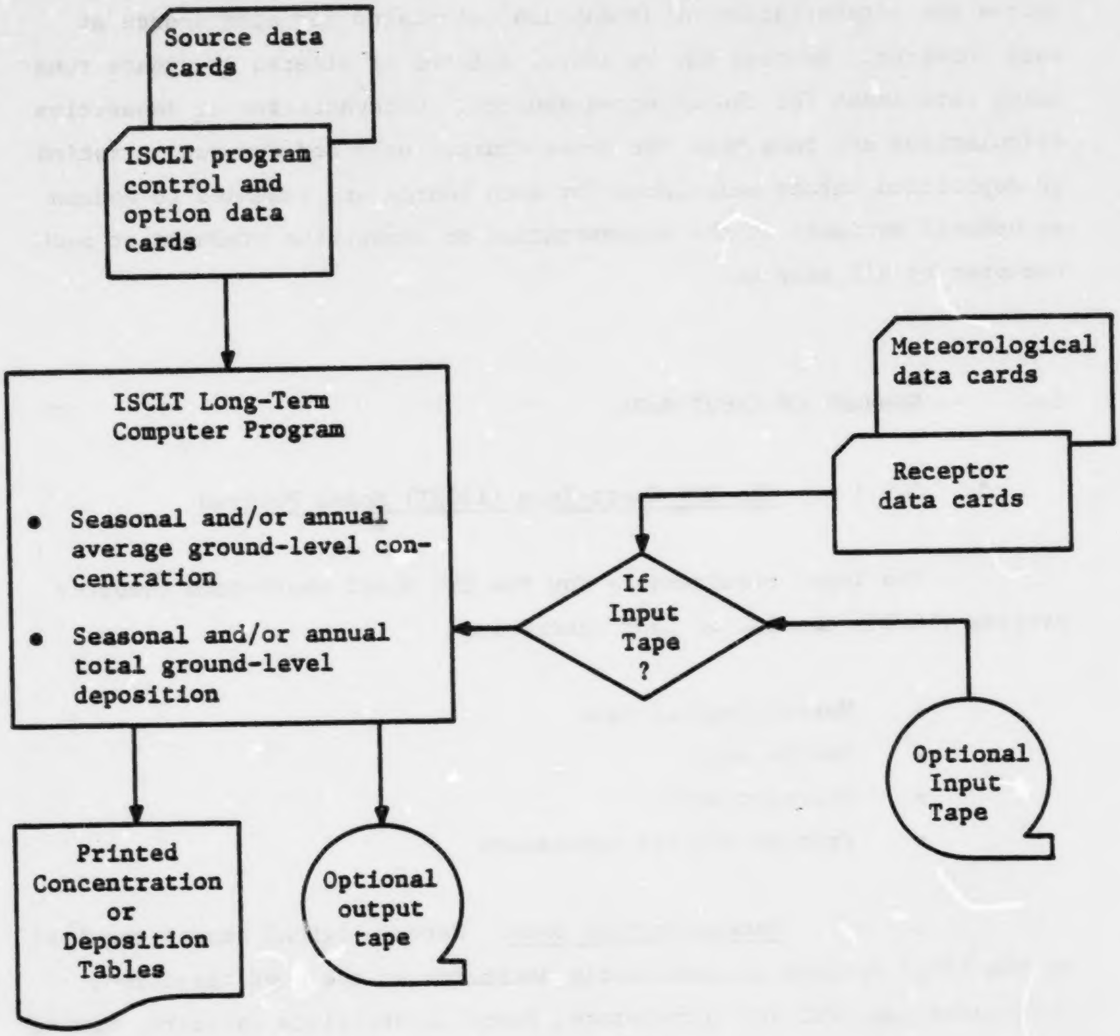
Source data cards
ISCLT program control and option data cards
ISCLT Long-Term Computer Program
• Seasonal and/or annual average ground-level concentration
• Seasonal and/or annual total ground-level deposition
Meteorological data cards
Receptor data cards
If Input Tape ?
Optional Input Tape
Printed Concentration or Deposition Tables
Optional output tape

FIGURE 1-2. Schematic diagram of the ISC Model long-term computer program ISCLT.

or deposition values. Additionally, all input data and the results of all calculations may be stored on an optional master tape inventory which can be used as input to future update runs. The master tape file stores the concentration or deposition calculated for each source at each receptor. Sources may be added, deleted or altered in update runs using card input for the affected sources. Concentration or deposition calculations are then made for those sources only and the concentration or deposition values calculated for each source are resummed to obtain an updated estimate of the concentration or deposition produced at each receptor by all sources.

1.4 SUMMARY OF INPUT DATA

1.4.1 The ISC Short-Term (ISCST) Model Program

The input requirements for the ISC Model short-term computer program (ISCST) consist of four categories:

- Meteorological data
- Source data
- Receptor data
- Program control parameters

a. Meteorological Data. Meteorological inputs required by the ISCST program include hourly estimates of the wind direction, wind speed, ambient air temperature, Pasquill stability category, mixing height, wind-profile exponent and vertical potential temperature gradient. The magnetic tape output of the meteorological data preprocessor program (see Appendix G) and the program default values for the wind-profile exponent and the vertical potential temperature gradient satisfy all ISCST hourly meteorological data requirements. Alternately, hourly meteorological data can be input by means of a card deck. The number of hours for which concentration or deposition calculations can be made ranges from 1 to 8,784 (i.e., up to every hour of a 366-day year).

b. Source Data. The ISCST program accepts three source types: stack, area and volume. For each source, input data requirements include the source location with respect to a user-specified origin, the source elevation (if terrain effects are to be included in the model calculations) and the pollutant emission rate. For each stack, additional source input requirements include the physical stack height, the stack inner diameter, the stack exit temperature, the stack exit velocity and -- if the stack is adjacent to a building and aerodynamic wake effects are to be considered -- the length, width and height of the building. The horizontal dimensions and effective emission height are required for each area source or volume source. If the calculations are to consider particulates with appreciable gravitational settling velocities, source inputs for each source also include the mass fraction of particulates in each gravitational settling-velocity category as well as the surface reflection coefficient and settling velocity of each settling-velocity category. Because industrial pollutant emission rates are often highly variable, emission rates for each source may be held constant or varied as follows:

- By hour of the day
- By season or month
- By hour of the day and season
- By stability and wind speed (applies to fugitive sources of wind-blown particulates)

c. Receptor Data. The ISCST program uses either a polar (r, θ) or a Cartesian (X, Y) coordinate system. The typical polar receptor array consists of 36 radials (one for every 10 degrees of azimuth) and five to ten downwind ring distances for a total of 180 to 360 receptors. However, the user is not restricted to a 10-degree angular separation of receptors. Receptor locations in the Cartesian coordinate system may be given as Universal Transverse Mercator (UTM) coordinates or as X (east-west) and Y (north-south) coordinates with respect to a user-specified origin. Discrete receptor points corresponding to the locations of air quality monitors, elevated terrain or other points of interest may also be used with either coordinate system. If terrain effects are to be included in the calculations, the elevation of each receptor is also required.

d. Program Control Parameters and Options. The ISCST program allows the user to select from a number of model options. The program parameters for these options are discussed in detail in Section 3.2.3. The available options include:

- Concentration/Deposition Option -- Directs the program to calculate average concentration or total deposition
- Receptor Grid System Option -- Selects a Cartesian or a polar receptor grid system
- Discrete Receptor Option -- Allows the user to arbitrarily place a receptor at any point using either a Cartesian or a polar coordinate system
- Receptor Terrain Elevation Option -- Allows the user to specify an elevation for each receptor (level terrain is assumed if this option is not exercised)
- Tape Output Option -- Directs the program to output the results of all concentration or deposition calculations to tape
- Print Input Data Option -- Directs the program to print program control parameters, source data and receptor data; the user may also direct the program to print the hourly meteorological data if this option is exercised

- Output Tables Option -- Specifies which of the four types of output tables are to be printed (see Section 3.1.3)

- Meteorological Data Option -- Directs the program to read hourly data from either the meteorological preprocessor format or a card image format

- Rural/Urban Option -- Specifies whether the concentration or deposition calculations are made in the Rural Mode, Urban Mode 1 or Urban Mode 2 (see Section 2.2.1.1)

- Wind-Profile Exponent Option -- Directs the program to read user-provided wind-profile exponents or to use the default values

- Vertical Potential Temperature Gradient Option -- Directs the program to read user-provided vertical potential temperature gradients or to use the default values

- Source Combination Option — Allows the user to specify the combinations of sources for which concentration or deposition estimates are required

- Single Time Period Interval Option — Directs the program to print concentration or deposition values for a specific time interval within a day (for example, the third 3-hour period)

- Variable Emission Rate Option -- Allows the user to specify scalars which are multiplied by the source's average emission rate; the scalars may vary by season or month, by hour of the day, by season and hour of the day, or by wind speed and stability

- Plume Rise as a Function of Distance Option -- Allows the user to direct the program to calculate plume rise as a function of downwind distance or to calculate final plume rise at all downwind distances

- Stack-Tip Downwash Option -- Allows the user to direct the program to use the Briggs (1973) procedures for evaluating stack-tip downwash for all stack sources

1.4.2 The ISC Long-Term (ISCLT) Model Program

The input requirements for the ISC Model long-term computer program (ISCLT) consist of four categories:

- Meteorological data
- Source data
- Receptor data
- Program control parameters

Each of these data categories is discussed separately below.

a. Meteorological Data. Seasonal or annual "STAR" summaries (statistical tabulations of the joint frequency of occurrence of wind-speed and wind-direction categories, classified according to the Pasquill stability categories)* are the principal meteorological inputs to ISCLT. The program accepts STAR summaries with six Pasquill stability categories (A through F) or five stability categories (A through E with the E and F categories combined). ISCLT is not designed to use the Climatological Dispersion Model (CDM) STAR summaries which subdivide the neutral D stability category into day and night D categories. Additional meteorological data requirements include seasonal average maximum and minimum mixing heights and ambient air temperatures.

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*STAR summaries are available from the National Climatic Center (NCC), Asheville, North Carolina.

b. Source Data. The ISCLT source data requirements are the same as those given in Section 1.4.1.b for the ISCST program.

c. Receptor Data. The ISCLT receptor data requirements are the same as those given in Section 1.4.1.c for the ISCST program.

d. Program Control Parameters and Options. The ISCLT program allows the user to select from a number of model and logic options. The program control parameters for these options are discussed in detail in Section 4.2.3. The available options include:

- Concentration/Deposition Option -- Directs the program to calculate average concentration or total deposition
- Receptor Grid System Option -- Selects a Cartesian or a polar receptor grid system
- Discrete Receptor Option -- Allows the user to place a receptor at any point using either a Cartesian or polar coordinate reference system
- Receptor Terrain Elevation Option -- Allows the user to specify an elevation for each receptor (level terrain is assumed by the program if this option is not exercised)
- Tape Input/Output Option -- Directs the program to input and/or output results of all concentration or deposition calculations, source data and meteorological data from and/or to magnetic tape or other data file
- Print Input Option -- Directs the program to print program control parameters, source data, receptor data and meteorological data

- Print Seasonal/Annual Results Option -- Directs the program to print seasonal and/or annual concentration or deposition values, where seasons are normally defined as winter, spring, summer and fall

- Print Results from Individual/Combined Source Option -- Directs the program to print the concentration or deposition values for individual and/or combined sources, where the combined source output is the sum over a select group of sources or all sources

- Rural/Urban Option -- Specifies whether the concentration or deposition calculations are to be made in the Rural Mode, Urban Mode 1 or Urban Mode 2 (see Section 2.2.1.1)

- Plume Rise as a Function of Distance Option -- Allows the user to direct the program to calculate plume rise as a function of downwind distance or to calculate final plume rise at all downwind distances

- Print Maximum 10/All Receptor Points Option -- Specifies whether the program is to print the maximum 10 concentration (deposition) values and receptors or to print the the results of the calculations at all receptors without maximums or both

- Automatic Determination of Maximum 10 Option — Directs the program to calculate the maximum 10 values of concentration (deposition) from the set of all receptors input; also, directs the program to display the 10 values of each contributing source at the locations determined by the maximum 10 values of the combined sources or to display the maximum 10 values and locations of each source individually

- User Specified Maximum 10 Option -- Allows the user the option of specifying up to 5 sets of 10 receptor points, one set for each seasonal and annual calculation or a single set of 10 receptor points, at which each source contribution as well as the total concentration (deposition) values for the combined sources are displayed

- Print Unit Option -- Allows the user to optionally direct the print output to any output device

- Tape Unit Option -- Allows the user to optionally select the logical unit numbers used for magnetic tape input and output

- Print Output Option -- This option is provided to minimize paper output; if selected, the program does not start a new page with each new table, but continues printing

- Lines per Page Option -- This option is provided to enable the user to specify the exact number of lines his installation printer prints per page

- Size Options -- These are parameters that allow the user to specify the number of sources input via data card, the sizes of the X and Y receptor axes if used, the number of discrete receptor points if used, the number of seasons (or annual only) in the meteorological input data, and the number of wind-speed, Pasquill stability and wind-direction categories in the input meteorological data

- Combined Sources Option -- Allows the user the option of specifying, by source number, multiple sets of sources to use in forming combined sources output or the option of using all sources in forming combined sources output

- Units Option -- Allows the user the option of specifying the input emissions units and/or output concentration or deposition units

- Variable Emissions Option -- Allows the user the option of varying emissions by season, by wind speed and season, by Pasquill stability category and season or by wind speed, Pasquill stability category and season (season is either winter, spring, summer, fall or annual only)

- Stack-Tip Downwash Option -- Allows the user to direct the program to use the Briggs (1973) procedures for evaluating stack-tip downwash for all sources

SECTION 2
TECHNICAL DESCRIPTION

2.1 GENERAL

The Industrial Source Complex (ISC) Dispersion Model is an advanced Gaussian plume model. The technical discussion contained in this section assumes that the reader is already familiar with the theory and concepts of Gaussian plume models. Readers who lack a fundamental knowledge of the basic concepts of Gaussian plume modeling are referred to Section 2 of the User's Manual for the Single Source (CRSTER) Model (EPA, 1977) or to other references such as Meteorology and Atomic Energy (Slade, 1968) or the Workbook of Atmospheric Dispersion Estimates (Turner, 1970).

2.2 MODEL INPUT DATA

2.2.1 Meteorological Input Data

2.2.1.1 Meteorological Inputs for the ISC Short-Term (ISCST) Model Program

Table 2-1 gives the hourly meteorological inputs required by the ISC Model short-term computer program (ISCST). These inputs include the mean wind speed measured at height z_1, the direction *toward which the wind is blowing,* the wind-profile exponent, the ambient air temperature, the Pasquill stability category and the vertical potential temperature gradient. In general, these inputs are developed from concurrent surface and upper-air meteorological data by the same preprocessor program as used by the Single Source (CRSTER) Model (see Appendix G). If the preprocessed meteorological data are used, the user may input, for each combination of wind-speed and Pasquill stability categories, site-specific values of the wind-profile exponent and the vertical potential temperature

TABLE 2-1

HOURLY METEOROLOGICAL INPUTS REQUIRED BY THE ISC SHORT-TERM MODEL PROGRAM

Parameter	Definition
$\bar{u}_1$	Mean wind speed in meters per second (m/sec) at height z_1 (default value for z_1 is 10 meters)
AFVR	Average random flow vector (direction toward which the wind is blowing)
p	Wind-profile exponent (default values assigned on the basis of stability; see Table 2-2)
T_a	Ambient air temperature in degrees Kelvin ($^{\circ}$K)
H_m	Depth of surface mixing layer (meters), developed from twice-daily mixing height estimates by the meteorological preprocessor program
Stability	Pasquill stability category (1 = A, 2 = B, etc.)
$\frac{\partial\Theta}{\partial z}$	Vertical potential temperature gradient in degrees Kelvin per meter (default values assigned on the basis of stability; see Table 2-2)

TABLE 2-2

DEFAULT VALUES FOR THE WIND-PROFILE EXPONENTS AND VERTICAL POTENTIAL TEMPERATURE GRADIENTS

Pasquill Stability Category	Wind-Profile Exponent p	Vertical Potential Temperature Gradient ($^{\circ}$K/m)
A	0.10	0.000
B	0.15	0.000
C	0.20	0.000
D	0.25	0.000
E	0.30	0.020
F	0.30	0.035

gradient. If the user does not input site-specific wind-profile exponents and vertical potential temperature gradients, the ISC Model uses the default values given in Table 2-2. The inputs listed in Table 2-1 may also be developed by the user from observed hourly meteorological data and input by card deck. In these cases, the direction from which the wind is blowing must be reversed 180 degrees to conform with the average flow vector (the direction toward which the wind is blowing) generated by the meteorological preprocessor program.

It should be noted that concentrations calculated using Gaussian dispersion models are inversely proportional to the mean wind speed and thus the calculated concentrations approach infinity as the mean wind speed approaches zero (calm). Also, there is no basis for estimating wind direction during periods of calm winds. The meteorological preprocessor program arbitrarily sets the wind speed equal to 1 meter per second if the observed wind speed is less than 1 meter per second and, in the case of calm winds, sets the wind direction equal to the value reported for the last non-calm hour. Thus, considerable uncertainties exist in the results of model calculations for hours with calm winds, especially if a series of consecutive calm hours occurs. In this case, the preprocessor program assumes a single persistent wind direction for the duration of the period of calm winds. Concentrations calculated for such periods may significantly overestimate the concentrations that can actually be expected to occur. Consequently, it is recommended that the ISCST user examine the preprocessed meteorological data for the periods with calculated maximum short-term concentrations to ensure that the results are not determined by an arbitrary assumption. Periods of persistent calm winds may be recognized by the combination of a constant wind direction with a wind speed of exactly 1.0 meter per second.

The ISCST program has a rural and two urban options. In the Rural Mode, rural mixing heights and the σ_y and σ_z values for the indicated stability category are used in the calculations. Urban mixing heights are used in both urban modes. In Urban Mode 1, the stable E and

F stability categories are redefined as neutral D stability following current EPA guidance. In Urban Mode 2, the E and F stability categories are combined and the σ_y and σ_z values for the stability category one step more unstable than the indicated category are used in the calculations. For example, the σ_y and σ_z values for C stability are used in calculations for D stability in Urban Mode 2. Table 2-3 gives the dispersion coefficients used in each mode.

The Rural Mode is usually selected for industrial source complexes located in rural areas. However, the urban options may also be considered in modeling an industrial source complex located in a rural area if the source complex is large and contains numerous tall buildings and/or large heat sources (for example, coke ovens). An urban mode is appropriate for these cases in order to account for the enhanced turbulence generated during stable meteorological conditions by the surface roughness elements and/or heat sources. If an urban mode is appropriate, Urban Mode 1 is recommended for most situations. Urban Mode 2 is primarily recommended for area sources in urban areas. Urban Mode 2 should not be used for stack sources in modeling studies for regulatory purposes.

2.2.1.2 Meteorological Inputs for the ISC Long-Term (ISCLT) Model Program

Table 2-4 lists the meteorological inputs required by the ISC Model long-term computer program (ISCLT). Seasonal or annual STAR summaries are the principal meteorological inputs to the ISCLT program. A STAR summary is a tabulation of the joint frequency of occurrence of wind-speed and wind-direction categories, classified according to the Pasquill stability categories. Table 2-5 identifies the combinations of wind-speed and Pasquill stability categories that are possible following the Turner (1964) procedures of using airport surface weather observations to estimate atmospheric stability. The wind-speed categories in Table 2-5 are in knots because the National Weather Service (NWS) reports airport wind speeds to the nearest knot. The default values of the wind

TABLE 2-3

PASQUILL-GIFFORD DISPERSION COEFFICIENTS USED BY THE ISC MODEL IN THE RURAL AND URBAN MODES

Actual Pasquill Stability Category*	Pasquill Stability Category for the σ_y, σ_z Values Used in ISC Model Calculations		
	Rural Mode	Urban Mode 1	Urban Mode 2
A	A	A	A
B	B	B	A
C	C	C	B
D	D	D	C
E	E	D	D
F	F	D	D

*The ISCST program redefines extremely stable G stability as very stable F stability.

TABLE 2-4

METEOROLOGICAL INPUTS REQUIRED BY THE ISC LONG-TERM MODEL PROGRAM

Parameter	Definition
$f_{i,j,k,\ell}$	Frequency of occurrence of the i^{th} wind-speed category and j^{th} wind-direction category by stability category k for the ℓ^{th} season (STAR summary)
$\bar{u}_1$	Mean wind speed in meters per second (m/sec) at height z_1 for each wind-speed category (default values based on STAR wind-speed categories)
$p_{j;k}$	Wind-profile exponent for each combination of wind-speed and stability categories (default values are assigned on the basis of stability; see Table 2-2)
$T_{a;k,\ell}$	Ambient air temperature for the k^{th} stability category and ℓ^{th} season in degrees Kelvin (°K)
$\frac{\partial\Theta}{\partial z}_{i,k}$	Vertical potential temperature gradient in degrees Kelvin per meter (°K/m) for each combination of wind-speed and stability categories (default values are assigned on the basis of stability; see Table 2-2)
$H_{m;i,k,\ell}$	Mixing height in meters for the i^{th} wind-speed category, k^{th} stability category and ℓ^{th} season

TABLE 2-5

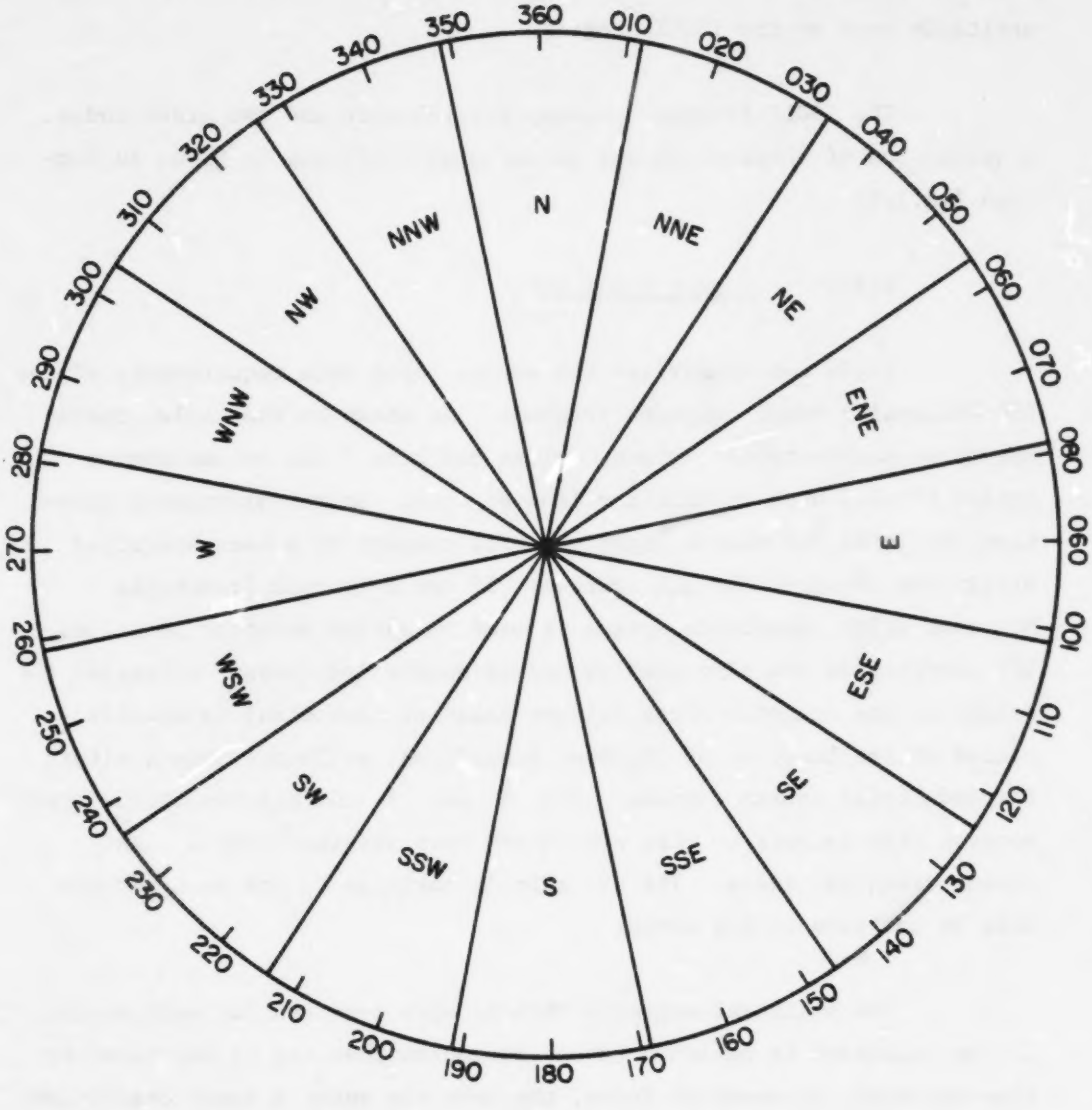
POSSIBLE COMBINATIONS OF WIND-SPEED AND PASQUILL STABILITY CATEGORIES* AND MEAN WIND SPEEDS IN EACH NCC STAR SUMMARY WIND-SPEED CATEGORY

Pasquill Stability Category	Wind Speed (kt)					
	0-3	4-6	7-10	11-16	17-21	>21
A	X	X				
B	X	X	X			
C	X	X	X	X	X	X
D	X	X	X	X	X	X
E		X	X			
F	X	X				
ISCLT Wind Speed (m/sec)	0.75	2.50	4.30	6.80	9.50	12.50

*Based on Turner (1964) definitions of the Pasquill stability categories.

speeds in meters per second assigned by ISCLT to each wind-speed category are shown at the bottom of Table 2-5. The sixteen standard 22.5-degree wind-direction sectors used in STAR summaries are shown in Figure 2-1. ISCLT accepts STAR summaries with six stability categories (A through F) or five stability categories (A through E with the E and F categories combined). ISCLT is not designed to use the Climatological Dispersion Model (CDM) STAR summaries which divide the neutral D stability category into day and night D categories. STAR summaries are available for most NWS surface weather stations from the National Climatic Center (NCC).

The ISCLT user must specify ambient air temperatures by stability and season and mixing heights by stability and/or wind-speed and season. It is suggested that the average seasonal maximum daily temperature be assigned to the A, B and C stability categories; the average seasonal minimum daily temperature be assigned to the E and F stability categories; and the average seasonal temperature be assigned to the D stability category. In urban areas, common practice is to assign the mean afternoon mixing height given by Holzworth (1972) to the B and C stability categories, 1.5 times the mean afternoon mixing height to the A stability category, the mean early morning mixing height to the E and F stability categories, and the average of the mean early morning and afternoon mixing heights to the D stability category. In rural areas, the applicability of Holzworth early morning urban mixing heights is questionable. Consequently, ISCLT in the Rural Mode currently assumes that there is no restriction on vertical mixing during hours with E and F stability. It is suggested that Holzworth mean afternoon mixing heights be assigned to the B, C and D stability categories in rural areas and that 1.5 times the mean afternoon mixing height be assigned to the A stability category. If sufficient climatological data are available, wind-profile exponents and vertical potential temperature gradients can be assigned by the user to each combination of wind-speed and stability categories in order to make the long-term model site specific. In the


360
010
020
030
040
050
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070
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090
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190
200
210
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270
280
290
300
310
320
330
340
350
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW

FIGURE 2-1. **The sixteen standard 22.5-degree wind-direction sectors used in STAR summaries.**

absence of site-specific wind-profile exponents and vertical potential temperature gradients, the default values given in Table 2-2 are automatically used by the ISCLT program.

The ISCLT program contains a rural mode and two urban modes. A discussion of these modes and guidance on their use is given in Section 2.2.1.1.

2.2.2 Source Input Data

Table 2-6 summarizes the source input data requirements of the ISC Dispersion Model computer programs. As shown by the table, there are three source types: stack, volume and area. The volume source option is also used to simulate line sources. Source elevations above mean sea level and source locations with respect to a user-specified origin are required for all sources. If the Universal Transverse Mercator (UTM) coordinate system is used to define receptor locations, UTM coordinates are also used to define source locations. Otherwise, the origin of the receptor array (either polar or Cartesian) is usually placed at the location of the most significant pollutant source within the industrial source complex. The X and Y coordinates of the other sources with respect to this origin are then obtained from a plant layout drawn to scale. The X axis is positive to the east and the Y axis is positive to the north.

The pollutant emission rate is also required for each source. If the pollutant is depleted by any mechanism that can be described by time-dependent exponential decay, the user may enter a decay coefficient ψ. The parameters ϕ_n, V_{sn} and γ_n are only required if concentration or deposition calculations are being made for particulates with appreciable gravitational settling velocities (diameters greater than about 20 micrometers). Particulate emissions from each source can be divided by the user into a maximum of 20 gravitational settling-velocity categories.

TABLE 2-6

SOURCE INPUTS REQUIRED BY THE ISC MODEL PROGRAMS

Parameter	Definition
Stacks	
Q	Pollutant emission rate for concentration calculations (mass per unit time)
Q_τ	Total pollutant emissions during the time period τ for which deposition is calculated (mass)
ψ	Pollutant decay coefficient (seconds^{-1})
X, Y	X and Y coordinates of the stack (meters)
Z_s	Elevation of base of stack (meters above mean sea level)
h	Stack height (meters)
V_s	Stack exit velocity (meters per second)
d	Stack inner diameter (meters)
T_s	Stack exit temperature (degrees Kelvin)
ϕ_n	Mass fraction of particulates in the n^{th} settling-velocity category
V_{sn}	Gravitational settling velocity for particulates in the n^{th} settling-velocity category (meters per second)
γ_n	Surface reflection coefficient for particulates in the n^{th} settling-velocity category
h_b	Height of building adjacent to the stack (meters)

TABLE 2-6 (Continued)

Parameter	Definition
W	Width of building adjacent to the stack (meters)
L	Length of building adjacent to the stack (meters)
Volume Source (Line Source)	
Q	Same definition as for stacks
Q_τ	Same definition as for stacks
ψ	Same definition as for stacks
X, Y	X and Y coordinates of the center of the volume source or of each volume source used to represent a line source (meters)
Z_s	Elevation of the ground surface at the point of the center of each volume source (meters above mean sea level)
H	Height of the center of each volume source above the ground surface (meters)
σ_{yo}	Initial horizontal dimension (meters)
σ_{zo}	Initial vertical dimension (meters)
ϕ_n	Same definition as for stacks
V_{sn}	Same definition as for stacks
γ_n	Same definition as for stacks
Area Source	
Q_A	Pollutant emission rate for concentration calculations (mass per unit time per unit area)

TABLE 2-6 (Continued)

Parameters	Definition
$Q_{A\tau}$	Total pollutant emissions during the time period τ for which deposition is calculated (mass per unit area)
ψ	Same definition as for stacks
X, Y	X and Y coordinates of the southwest corner of the square area source (meters)
Z_s	Elevation of the area source (meters above mean sea level)
H	Effective emission height of the area source (meters)
x_o	Width of the square area source (meters)
ϕ_n	Same definition as for stacks
V_{sn}	Same definition as for stacks
γ_n	Same definition as for stacks

Emission rates used by the short-term model program ISCST may be held constant or may be varied as follows:

- By hour of the day
- By season or month
- By hour of the day and season
- By wind-speed and stability categories (applies to fugitive sources of wind-blown dust)

Emission rates used by the long-term model program ISCLT may be annual average rates or may be varied by season or by wind-speed and stability categories.

Additional source inputs required for stacks include the physical stack height, the stack exit velocity, the stack inner diameter and the stack exit temperature. For an area source or a volume source, the dimensions of the source and the effective emission height are entered in place of these parameters. If a stack is located on or adjacent to a building and the stack height to building height ratio is less than 2.5, the length (L) and width (W) of the building are required as source inputs in order to include aerodynamic wake effects in the model calculations. *The building wake effects option is automatically exercised if building dimensions are entered.*

2.2.3 Receptor Data

The ISC Dispersion Model computer programs allow the user to select either a Cartesian (X, Y) or a polar (r, θ) receptor grid system. In the Cartesian system, the X-axis is positive to the east of a user-specified origin and the Y-axis is positive to the north. In the polar system, r is the radial distance measured from the user-specified origin and the angle θ (azimuth bearing) is measured clockwise from north. If pollutant emissions are dominated by a single source or by a group of sources in close proximity, a polar coordinate system with its origin at the location of the dominant source or sources is the preferred receptor grid system. However, if the industrial source complex is comprised of multiple sources that are not located at the same point, a Cartesian coordinate system is usually more convenient. Additionally, if the Universal Transverse Mercator (UTM) coordinate system is used to define source locations and/or to extract the elevations of receptor points from USGS topographic maps, the UTM system can also be used in the ISC Model calculations. Discrete (arbitrarily placed) receptor points corresponding to the locations of air quality monitors, elevated terrain features, the property boundaries of the industrial source complex or other points of interest can be used with either coordinate system.

In the polar coordinate system, receptor points are usually spaced at 10-degree intervals on concentric rings. Thus, there are 36 receptors on each ring. The radial distances from the origin to the receptor rings are user selected and are generally set equal to the distances to the expected maximum ground-level concentrations for the major pollutant sources under the most frequent stability and wind-speed combinations. Estimates of these distances can be obtained from the PTMAX computer program (Turner and Busse, 1973) or from preliminary calculations using the ISCST computer program. The maximum number of receptor points is determined by factors such as the number of sources and the desired output (see Equation (3-1) for the short-term model and Equations (4-1), (4-2) and (4-3) for the long-term model). An example of a polar receptor array is shown in Figure 2-2.

In the Cartesian coordinate system, the X and Y coordinates of the receptors are specified by the user. The spacing of grid points is not required to be uniform so that the density of grid points can be greatest in the area of the expected maximum ground-level concentrations.

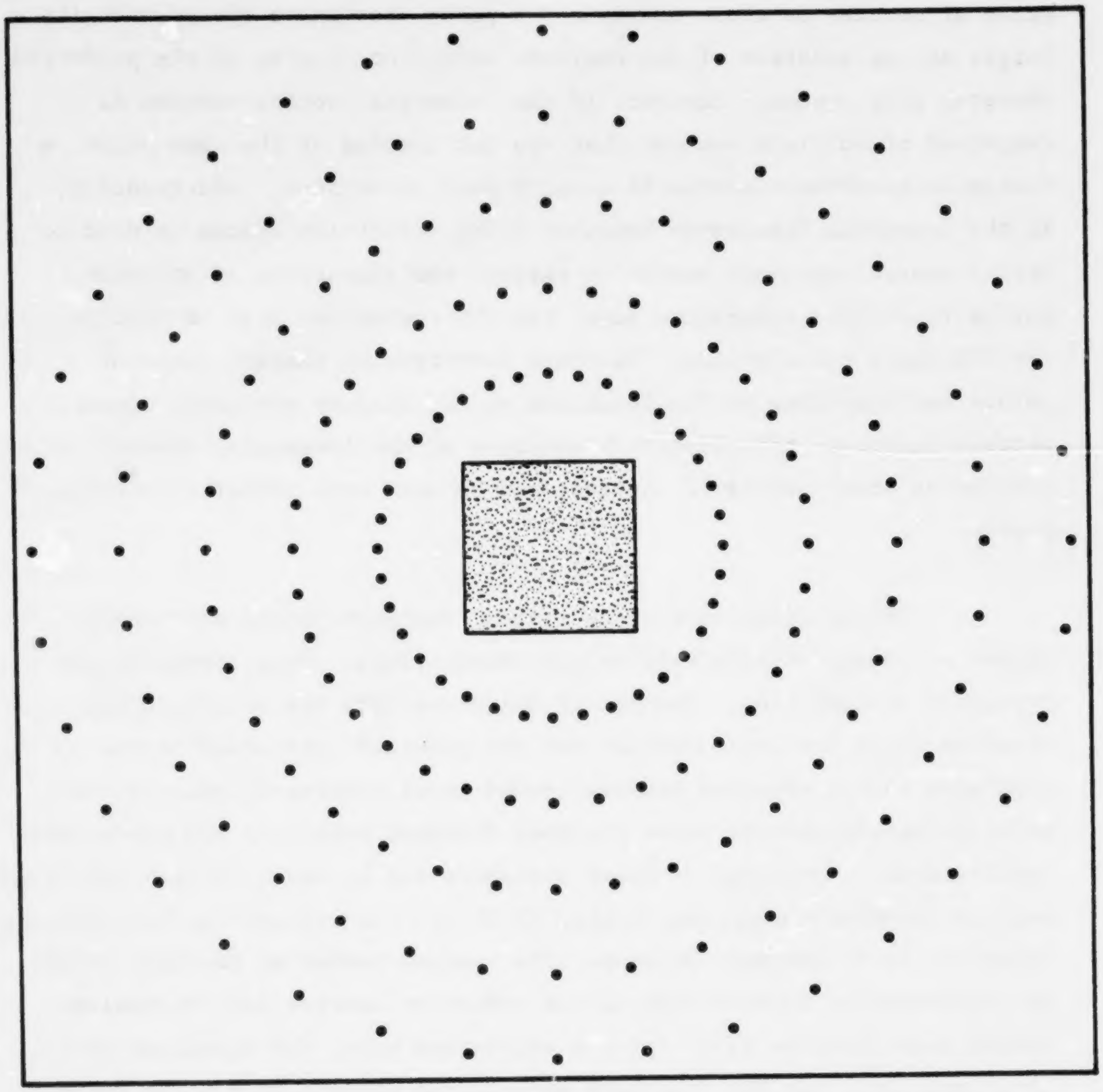


FIGURE 2-2. Example of a polar receptor grid. The stippled area shows the property of a hypothetical industrial source complex.

For example, assume that an industrial source complex is comprised of a number of major sources, contained within a 1-kilometer square, whose maximum ground-level concentrations are expected to occur at downwind distances ranging from 500 to 1000 meters. The Cartesian receptor grid {X and Y = 0, ±200, ±400, ±600, ±800, ±1,000, ±1,200, ±1,500, ±2,000, ±3,000} illustrated in Figure 2-3 provides a dense spacing of grid points in the areas where the highest concentrations are expected to occur. As shown by Figure 2-3, use of the Cartesian system requires that some of the receptor points be located within the property of the source complex. Also, some of the receptors may be located within 100 meters of an individual source. If a receptor is located within 100 meters of a source, a warning message is printed and concentrations are not calculated for the source-receptor combination. The 100-meter restriction, which arises from the fact that the Pasquill-Gifford curves begin at 100 meters, is not a problem in this case because the concentrations of concern are the concentrations calculated at and beyond the property boundaries of the source complex. Comparison of Figures 2-2 and 2-3 shows that, for the hypothetical industrial source complex described above, the Cartesian receptor array is more likely to detect the maximum concentrations produced by the combined emissions from the various sources within the industrial source complex than is the polar receptor array.

As noted above, discrete (arbitrarily spaced) receptor points may be entered using either a polar or a Cartesian coordinate system. In general, discrete receptor points are placed at the locations of air quality monitors, the boundaries of the property of an industrial source complex or at other points of interest. However, discrete receptor points can be used for many purposes. For example, assume that a proposed coal-fired power plant will be located approximately 30 kilometers from a National Park that is a Class I (pristine air quality) area and that it is desired to determine whether the 3-hour and 24-hour Class I Non-Deterioration Increments for SO_2 will be exceeded on more

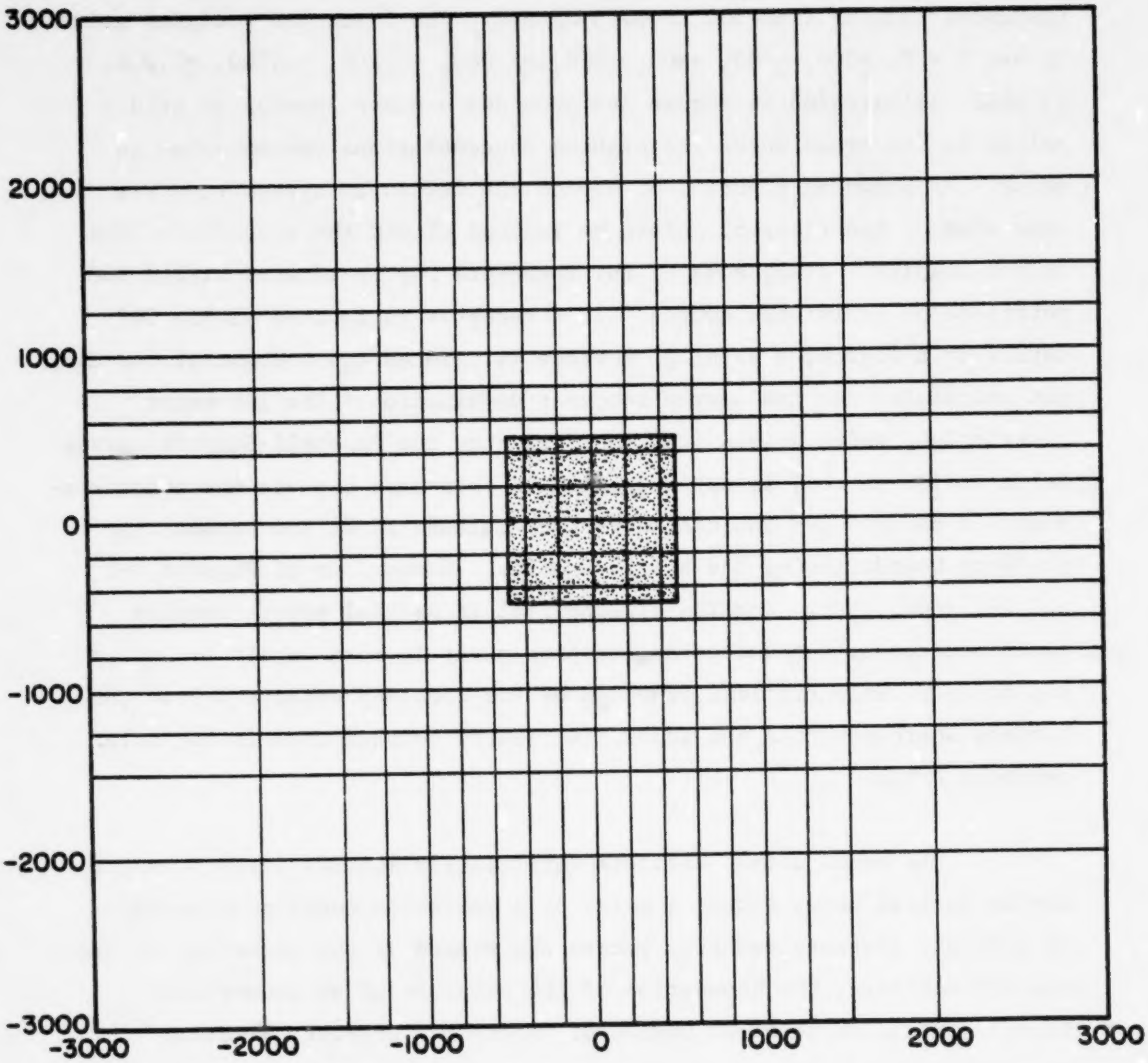

3000
2000
1000
0
-1000
-2000
-3000
-3000
-2000
-1000
0
1000
2000
3000

FIGURE 2-3. **Example of an irregularly-spaced Cartesian receptor grid. The stippled area shows the property of a hypothetical industrial source complex.**

than 18 days per year. The angular dimensions of the areas within which the 3-hour and 24-hour Class I Non-Deterioration Increments for SO_2 are exceeded are usually less than 10 degrees. It follows that a polar coordinate system with a 10-degree angular separation of receptors is not adequate to detect all occurrences of 3-hour and 24-hour SO_2 concentrations above the short-term Class I SO_2 Increments. The user may therefore wish to place discrete receptors at 1-degree intervals along the boundary of and within the Class I area.

If model calculations are to be made for an industrial source complex located in complex terrain, the elevation above mean sea level of each receptor must be input. *If the elevation of any receptor exceeds the height of any stack or the effective emission height of any volume source, an error message is printed and program execution is terminated.*

2.3 PLUME RISE FORMULAS

The effective stack height H of a plume with momentum and/or thermal buoyancy is given by the sum of the physical stack height h and the plume rise Δh. The ISC Model programs use the generalized Briggs (1971, 1975) plume-rise equations. Parameters used in these equations are defined as follows:

$$F_m = \left(T_a/T_s\right) V_s^2 \, d^2/4 \tag{2-1}$$

$$F = \left\{ \begin{array}{ll} F' = \dfrac{g\, V_s\, d^2}{4} \left(1 - T_a/T_s\right) & ;\ F' > F_c \\ 0 & ;\ F' \leq F_c \end{array} \right\} \tag{2-2a}$$

$$F_c = \left\{ \begin{array}{ll} 0.0727\ (V_s d)^{4/3}\ ; & F' \leq 55\ m^4/sec^3 \\ 0.0141\ (V_s d)^{5/3}\ ; & F' > 55\ m^4/sec^3 \end{array} \right\} \tag{2-2b}$$

$$\beta_j = \left(1/3 + \frac{\bar{u}\{h\}}{V_s}\right) \tag{2-3}$$

where

F_m = momentum flux term

F = buoyancy flux term

F_c = buoyancy flux below which plume rise is due to momentum only

β_j = jet entrainment coefficient

T_a = ambient air temperature (^oK)

T_s = stack exit temperature (^oK), input as zero for a pure momentum source

V_s = stack exit velocity (m/sec), input as zero if no plume rise is to be calculated

d = stack inner diameter (m)

g = acceleration due to gravity (9.8 m/sec^2)

$\bar{u}\{h\}$ = mean wind speed (m/sec) at emission height h

If the vertical potential temperature gradient is less than or equal to zero (the default value for the A, B, C and D Pasquill stability categories), plume rise Δh_N due to buoyancy and/or momentum at downwind distance x is given by

$$\Delta h_N\{x\} = \left[\frac{3F_m\ x'}{\beta_j^2\ \bar{u}\{h\}^2} + \frac{3F\ x'^2}{2\beta_1^2\ \bar{u}\{h\}^3}\right]^{1/3} \tag{2-4}$$

$$x' = \left\{ \begin{array}{ll} x & ; \; x < 3.5\, x^* \quad \text{and} \quad F > 0 \\[2ex] x & ; \; x < \dfrac{4d\left(V_s + 3\bar{u}\{h\}\right)^2}{V_s \bar{u}\{h\}} \quad \text{and} \quad F = 0 \\[2ex] 3.5\, x^* & ; \; x \geq 3.5\, x^* \quad \text{and} \quad F > 0 \\[2ex] \dfrac{4d\left(V_s + 3\bar{u}\{h\}\right)^2}{V_s\, \bar{u}\{h\}} & ; \; x \geq \dfrac{4d\left(V_s + 3\bar{u}\{h\}\right)^2}{V_s\, \bar{u}\{h\}} \quad \text{and} \quad F = 0 \end{array} \right\} \quad (2\text{-}5)$$

$$x^* = \left\{ \begin{array}{l} 14\, F^{5/8}; \quad F \leq 55\ \text{m}^4/\text{sec}^3 \\[1ex] 34\, F^{2/5}; \quad F > 55\ \text{m}^4/\text{sec}^3 \end{array} \right\} \quad (2\text{-}6)$$

where the default value for the adiabatic entrainment coefficient β_1 is 0.6 (Briggs, 1975). It should be noted that Equation (2-4) is a theoretical formulation. At present, sufficient experimental data to determine the validity of the final plume rises yielded by Equation (2-4) for non-buoyant plumes are not available.

If the vertical potential temperature gradient is positive, plume rise Δh_s at downwind distance x is given by

$$\Delta h_s\{x\} = \left[\frac{3F_m}{\beta_j^2\, \bar{u}\{h\}\, S^{1/2}} \sin\left(S^{1/2}\, x'/\bar{u}\{h\}\right) + \frac{3F}{\beta_2^2\, \bar{u}\{h\}\, S} \left(1 - \cos\left(S^{1/2}\, x'/\bar{u}\{h\}\right)\right) \right]^{1/3} \quad (2\text{-}7)$$

$$x' = \left\{\begin{array}{ll} x & ;\ x < \pi\,\bar{u}\{h\}\,S^{-1/2} \ \text{and}\ F > 0 \\ x & ;\ x < \frac{\pi}{2}\,\bar{u}\{h\}\,S^{-1/2} \ \text{and}\ F = 0 \\ \pi\,\bar{u}\{h\}\,S^{-1/2}; & x \geq \pi\,\bar{u}\{h\}\,S^{-1/2} \ \text{and}\ F > 0 \\ \frac{\pi}{2}\,\bar{u}\{h\}\,S^{-1/2}; & x \geq \frac{\pi}{2}\,\bar{u}\{h\}\,S^{-1/2} \ \text{and}\ F = 0 \end{array}\right\} \quad (2\text{-}8)$$

$$S = \frac{g}{T_a}\frac{\partial\Theta}{\partial z} \quad (2\text{-}9)$$

where

S = stability parameter

$\frac{\partial\theta}{\partial z}$ = vertical potential temperature gradient (the default value is 0.020°K/m for E stability and 0.035°K/m for F stability)

The default value for the stable entrainment coefficient β_2 is 0.6 (Briggs, 1975). It should be noted that, if the buoyancy parameter F is equal to zero and $\Delta h_s\{x\}$ is greater than $3V_s d/\bar{u}\{h\}$, the ISC Model programs set $\Delta h_s\{x\}$ equal to $3V_s d/\bar{u}\{h\}$. Equation (2-7) is a theoretical formulation. In the case of non-buoyant plumes, sufficient experimental data to determine the validity of the final plume rises calculated by Equation (2-7) currently are not available.

It is important to note that the calculation of plume rise as a function of downwind distance is an ISC Model option. If the ISC Model programs are not directed to calculate plume rise as a function of downwind distance, the programs will assume that the final plume rise applies at all downwind distances. The final plume rise with an adiabatic or unstable thermal stratification is given by Equation (2-4) with x' set equal to the maximum value allowed by Equation (2-5). Similarly, the final plume rise with a stable thermal stratification is given by Equation (2-7) with x' set equal to the maximum value allowed by Equation (2-8).

A wind-profile exponent law is used to adjust the mean wind speed $\bar{u}_1$ from the wind system measurement height z_1 (default value of 10 meters) to the emission height h. This law is of the form

$$\bar{u}\{h\} = \bar{u}_1 \left(\frac{h}{z_1}\right)^p \tag{2-10}$$

where p is the wind-profile exponent. The default values for p are given in Table 2-2.

As an option, the user may direct the ISC Model programs to consider stack-tip downwash for all stacks following the suggestions of Briggs (1973). The physical stack height h is replaced by an adjusted stack height h', which is defined as

$$h' = \left\{ \begin{array}{ll} h & ; \; V_s \geq 1.5\, \bar{u}\{h\} \\ \\ h + 2\left[V_s/\bar{u}\{h\} - 1.5\right] d & ; \; V_s < 1.5\, \bar{u}\{h\} \end{array} \right\} \tag{2-11}$$

The user is cautioned that Equation (2-11) is based on data obtained in an aeronautical wind tunnel without airstream turbulence and without proper Froude number scaling for buoyancy effects (see Halitsky, 1978). Additionally, the published data upon which Equation (2-11) is based (Sherlock and Stalker, 1941) refer to the downward displacement of the lower plume boundary rather than to the downward displacement of the plume centerline.

2.4 THE ISC SHORT-TERM DISPERSION MODEL EQUATIONS

2.4.1 Stack Emissions

The ISC short-term concentration model for stacks uses the steady-state Gaussian plume equation for a continuous elevated source. For each stack and each hour, the origin of the stack's coordinate system is placed at the ground surface at the base of the stack. The x axis is positive in the downwind direction, the y axis is crosswind (normal) to the x axis and the z axis extends vertically. The fixed receptor locations are converted to each stack's coordinate system for each hourly concentration calculation. The hourly concentrations calculated for each stack at each receptor are summed to obtain the total concentration produced at each receptor by the combined stack emissions.

The hourly ground-level concentration at downwind distance x and crosswind distance y is given by

$$\chi\{x,y\} = \frac{KQ}{\pi\ \bar{u}\{h\}\ \sigma_y\ \sigma_z}\ \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)\right]^2 \qquad (2\text{-}12)$$

{Vertical Term} {Decay Term}

where

Q = pollutant emission rate (mass per unit time)

K = a scaling coefficient to convert calculated concentrations to desired units (default value of 1×10^6 for Q in g/sec and concentration in $\mu g/m^3$)

σ_y, σ_z = standard deviation of lateral, vertical concentration distribution (m)

$\bar{u}\{n\}$ = mean wind speed (m/sec) at stack height h

Equation (2-12) includes a Vertical Term, a Decay Term, and dispersion coefficients (σ_y and σ_z). The dispersion coefficients and the Vertical Term are discussed below. It should be noted that the Vertical Term includes the effects of source elevation, plume rise, limited mixing in the vertical, and the gravitational settling and dry deposition of larger particulates (particulates with diameters greater than about 20 micrometers).

The Decay Term, which is a simple method of accounting for pollutant removal by physical or chemical processes, is of the form

$$\{\text{Decay Term}\} = \exp\left[-\psi \; x/\bar{u}\{h\}\right] \qquad (2\text{-}13)$$

where

ψ = the decay coefficient (sec^{-1})

For example, if $T_{1/2}$ is the pollutant half life in seconds, the user can obtain ψ from the relationship

$$\psi = \frac{0.693}{T_{1/2}} \qquad (2\text{-}14)$$

The default value for ψ is zero. That is, decay is not considered in the model calculations unless ψ is specified.

In addition to stack emissions, the ISC short-term concentration model considers emissions from area and volume sources. The volume-source option is also used to simulate line sources. These model options are described in Section 2.4.2. Section 2.4.3 gives the optional algorithms for calculating dry deposition for stack, area and volume sources.

2.4.1.1 The Dispersion Coefficients

a. Point Source Dispersion Coefficients. Equations that approximately fit the Pasquill-Gifford curves (Turner, 1970) are used to calculate σ_y and σ_z. The equations used to calculate σ_y are of the form

$$\sigma_y = 465.11628 \ x \ \tan(TH) \tag{2-15}$$

$$TH = 0.017453293 \ (c - d \ln x) \tag{2-16}$$

where the downwind distance x is in kilometers in Equations (2-15) and (2-16); the coefficients c and d are listed in Table 2-7. The equation used to calculate σ_z is of the form

$$\sigma_z = ax^b \tag{2-17}$$

where the downwind distance x is in kilometers in Equation (2-17) and the coefficients a and b are given in Table 2-8.

TABLE 2-7

PARAMETERS USED TO CALCULATE σ_y

Pasquill Stability Category	$\sigma_y = 465.11628\ x(\mathrm{km})\ \tan(\mathrm{TH})$ $\mathrm{TH} = 0.017453293\left(c - d \ln\left(x(\mathrm{km})\right)\right)$	
	c	d
A	24.1670	2.5334
B	18.3330	1.8096
C	12.5000	1.0857
D	8.3330	0.72382
E	6.2500	0.54287
F	4.1667	0.36191

TABLE 2-8

PARAMETERS USED TO CALCULATE σ_z

Pasquill Stability Category	x (km)	$\sigma_z = a\,x(\text{km})^b$	
		a	b
A*	0.10 - 0.15	158.080	1.05420
	0.16 - 0.20	170.220	1.09320
	0.21 - 0.25	179.520	1.12620
	0.26 - 0.30	217.410	1.26440
	0.31 - 0.40	258.890	1.40940
	0.41 - 0.50	346.750	1.72830
	0.51 - 3.11	453.850	2.11660
	>3.11	**	**
B*	0.10 - 0.20	90.673	0.93198
	0.21 - 0.40	98.483	0.98332
	>0.40	109.300	1.09710
C*	>0.10	61.141	0.91465
D	0.10 - 0.30	34.459	0.86974
	0.31 - 1.00	32.093	0.81066
	1.01 - 3.00	32.093	0.64403
	3.01 - 10.00	33.504	0.60486
	10.01 - 30.00	36.650	0.56589
	>30.00	44.053	0.51179

*If the calculated value of σ_z exceeds 5000 m, σ_z is set to 5000 m.

**σ_z is equal to 5000 m.

TABLE 2-8 (Continued)

Pasquill Stability Category	x (km)	$\sigma_z = a\ x(\text{km})^b$	
		a	b
E	0.10 - 0.30	23.331	0.81956
	0.31 - 1.00	21.628	0.75660
	1.01 - 2.00	21.628	0.63077
	2.01 - 4.00	22.534	0.57154
	4.01 - 10.00	24.703	0.50527
	10.01 - 20.00	26.970	0.46713
	20.01 - 40.00	35.420	0.37615
	>40.00	47.618	0.29592
F	0.10 - 0.20	15.209	0.81558
	0.21 - 0.70	14.457	0.78407
	0.71 - 1.00	13.953	0.68465
	1.01 - 2.00	13.953	0.63227
	2.01 - 3.00	14.823	0.54503
	3.01 - 7.00	16.187	0.46490
	7.01 - 15.00	17.836	0.41507
	15.01 - 30.00	22.651	0.32681
	30.01 - 60.00	27.074	0.27436
	>60.00	34.219	0.21716

b. Downwind and Crosswind Distances. As noted in Section 2.2.3, the ISC Model uses either a polar or a Cartesian receptor grid as specified by the user. In the polar coordinate system, the radial coordinate of the point (r, Θ) is measured from the user-specified origin and angular coordinate Θ is measured clockwise from north. In the Cartesian coordinate system, the X axis is positive to the east of the user-specified origin and the Y axis is positive to the north. For either type of receptor grid, the user must define the location of each source with respect to the origin of the grid using Cartesian coordinates. In the polar coordinate system, the X and Y coordinates of a receptor at the point (r, Θ) are given by

$$X(R) = r \sin \Theta \qquad (2\text{-}18)$$

$$Y(R) = r \cos \Theta \qquad (2\text{-}19)$$

If the X and Y coordinates of the source are X(S) and Y(S), the downwind distance x to the receptor is given by

$$x = -\big(X(R) - X(S)\big) \sin DD - \big(Y(R) - Y(S)\big) \cos DD \qquad (2\text{-}20)$$

where DD is the direction from which the wind is blowing. If any receptor is located within 100 meters of a source, a warning message is printed and no concentrations are calculated for the source-receptor combination. The crosswind distance y to the receptor (see Equation (2-12)) is given by

$$y = -\big(Y(R) - Y(S)\big) \sin DD + \big(X(R) - X(S)\big) \cos DD \qquad (2\text{-}21)$$

c. Lateral and Vertical Virtual Distances. Equations (2-15) through (2-17) define the dispersion coefficients for an ideal point source. However, volume sources have initial lateral and vertical dimensions. Also, as discussed below, building wake effects can enhance the initial growth of stack plumes. In these cases, lateral (x_y) and vertical (x_z) virtual distances are added by the ISC Model to the actual downwind distance x for the σ_y and σ_z calculations. The lateral virtual distance in kilometers is given by

$$x_y(\text{km}) = \left(\frac{\sigma_{yo}\ (\text{m})}{p}\right)^{1/q} \tag{2-22}$$

where the stability-dependent coefficients p and q are given in Table 2-9 and σ_{yo} is the standard deviation of the lateral concentration distribution at the source. Similarly, the vertical virtual distance in kilometers is given by

$$x_z\ (\text{km}) = \left(\frac{\sigma_{zo}\ (\text{m})}{a}\right)^{1/b} \tag{2-23}$$

where the coefficients a and b are obtained from Table 2-8 and σ_{zo} is the standard deviation of the vertical concentration distribution at the source. It is important to note that the ISC Model programs check to ensure that the x_z used to calculate $\sigma_z\{x+x_z\}$ is the x_z calculated using the coefficients a and b that correspond to the distance category specified by the quantity $(x + x_z)$.

d. Procedures Used to Account for the Effects of Building Wakes on Effluent Dispersion. The procedures used by the ISC Model to account for the effects of the aerodynamic wakes and eddies produced by plant buildings and structures on plume dispersion follow the suggestions of Huber and Snyder (1976) and Huber (1977). Their suggestions are princi-

TABLE 2-9

COEFFICIENTS USED TO CALCULATE LATERAL VIRTUAL DISTANCES

Pasquill Stability Category	$x_y = \left(\frac{\sigma_{yo}}{p}\right)^{1/q}$	
	p	q
A	209.14	0.890
B	154.46	0.902
C	103.26	0.917
D	68.26	0.919
E	51.06	0.921
F	33.92	0.919

pally based on the results of wind-tunnel experiments using a model building with a crosswind dimension double that of the building height. The atmospheric turbulence simulated in the wind-tunnel experiments was intermediate between the turbulent intensity associated with the slightly unstable Pasquill C category and the turbulent intensity associated with the neutral D category. Thus, the data reported by Huber and Snyder reflect a specific stability, building shape and building orientation with respect to the mean wind direction. It follows that the ISC Model wake-effects evaluation procedures may not be strictly applicable to all situations. However, the suggestions of Huber and Snyder are based on the best available data and are used by the ISC Model as interim procedures until additional data become available.

The wake-effects evaluation procedures may be applied by the user to any stack on or adjacent to a building. *The distance-dependent plume rise option generally should be used with the building wake effects option. Additionally, because the effects of stack-tip downwash (see Equation (2-11)) are implicitly included in the building wake effects option, the stack-tip downwash option normally should not be used in combination with the building wake effects option.* The first step in the wake-effects evaluation procedures used by the ISC Model programs is to calculate the plume rise due to momentum alone at a distance of two building heights downwind from the stack. Equation (2-4) or Equation (2-7) with the buoyancy parameter F set equal to zero is used to calculate this momentum rise. If the plume height, given by the sum of the stack height and the momentum rise at a downwind distance of two building heights, is greater than either 2.5 building heights (2.5 h_b) or the sum of the building height and 1.5 times the building width ($h_b + 1.5\ h_w$), the plume is assumed to be unaffected by the building wake. Otherwise, the plume is assumed to be affected by the building wake.

The ISC Model programs account for the effects of building wakes by modifying σ_z for plumes from stacks with plume height to building height ratios greater than 1.2 (but less than 2.5) and by modifying both σ_y and σ_z for plumes with plume height to building height ratios less than or equal to 1.2. The plume height used in the plume height to stack height ratios is the same plume height used to determine if the plume is affected by the building wake. The ISC Model defines buildings as squat ($h_w \geq h_b$) or tall ($h_w < h_b$). The building width h_w is approximated by the diameter of a circle with an area equal to the horizontal area of the building. The ISC Model includes a general procedure for modifying σ_z and σ_y at distances greater than 3 h_b for squat buildings or 3 h_w for tall buildings. The air flow in the building cavity region is both highly turbulent and generally recirculating. The ISC Model is not appropriate for estimating concentrations within such regions. The ISC Model assumption that this recirculating cavity region extends to a downwind distance of 3 h_b for a squat building or 3 h_w for a tall building is most appropriate for a building whose width is not much greater than its height. The ISC Model user is cautioned that, for other types of buildings, receptors located at downwind distances of 3 h_b (squat buildings) or 3 h_w (tall buildings) may be within the recirculating region. Some guidance and techniques for estimating concentrations very near buildings can be found in Barry (1964), Halitsky (1963) and Vincent (1977). The downwash procedure found in Budney (1977) may also be used to obtain a "worst-case" estimate.

The modified σ_z equation for a squat building is given by

$$\sigma_z' = \left\{ \begin{array}{ll} 0.7h_b(m) + 0.067\left[x(m) - 3h_b(m)\right]; & 3h_b(m) < x(m) < 10h_b(m) \\ \\ \sigma_z\left\{x(km) + x_z(km)\right\} ; & x(m) \geq 10h_b(m) \end{array} \right\} \quad (2\text{-}24)$$

where the building height h_b is in meters. For a tall building, Huber (1977) suggests that the width scale h_w replace h_b in Equation (2-24).

The modified σ_z equation for a tall building is then given by

$$\sigma_z' = \left\{ \begin{array}{ll} 0.7h_w(\mathrm{m}) + 0.067 \left[x(\mathrm{m}) - 3h_w(\mathrm{m})\right] \; ; & 3h_w < x(\mathrm{m}) < 10h_w(\mathrm{m}) \\ \sigma_z \left\{x(\mathrm{km}) + x_z(\mathrm{km})\right\} \; ; & x(\mathrm{m}) \geq 10h_w(\mathrm{m}) \end{array} \right\} \quad (2\text{-}25)$$

where h_w is in meters. It is important to note that σ_z' is not permitted to be less than the point source value given by Equation (2-17), a condition that may occur with the A and B stability categories.

The vertical virtual distance x_z is added to the actual downwind distance x at downwind distances beyond $10h_b$ (squat buildings) or $10h_w$ (tall buildings) in order to account for the enhanced initial plume growth caused by the building wake. Equations (2-17) and (2-24) can be combined to derive the vertical virtual distance x_z for a squat building. First, it follows from Equation (2-24) that σ_z is equal to $1.2h_b$ at a downwind distance of $10h_b$ in meters or $0.01\ h_b$ in kilometers. Thus, x_z for a squat building is obtained from Equation (2-17) as follows:

$$\sigma_z \left\{0.01h_b\right\} = 1.2h_b = a\left(0.01h_b + x_z\right)^b \quad (2\text{-}26)$$

$$x_z = \left(\frac{1.2h_b}{a}\right)^{1/b} - 0.01h_b \quad (2\text{-}27)$$

where the stability-dependent constants a and b are given in Table 2-8. Similarly, the vertical virtual distance for tall buildings is given by

$$x_z = \left(\frac{1.2h_w}{a}\right)^{1/b} - 0.01h_w \quad (2\text{-}28)$$

For a squat building with a building width to building height ratio h_w/h_b less than or equal to 5, the modified σ_y equation is given by

$$\sigma'_y = \begin{cases} 0.35h_w(\mathrm{m}) + 0.067\left[x(\mathrm{m}) - 3h_b(\mathrm{m})\right] & ; \quad 3h_b < x(\mathrm{m}) < 10h_b(\mathrm{m}) \\ \sigma_y\left\{x(\mathrm{km}) + x_y(\mathrm{km})\right\} & ; \quad x(\mathrm{m}) \geq 10h_b(\mathrm{m}) \end{cases} \qquad (2\text{-}29)$$

with the lateral virtual distance x_y given by

$$x_y = \left(\frac{0.35h_w + 0.5h_b}{p}\right)^{1/q} - 0.01h_b \qquad (2\text{-}30)$$

The stability-dependent coefficients p and q are given in Table 2-9.

For building width to building height ratios h_w/h_b greater than 5, the presently available data are insufficient to provide general equations for σ_y. For a building that is much wider than it is tall and a stack located toward the center of the building (i.e., away from either end), only the height scale is considered to be significant. The modified σ_y equation for a squat building is then given by

$$\sigma'_y = \begin{cases} 0.35h_b(\mathrm{m}) + 0.067\left[x(\mathrm{m}) - 3h_b(\mathrm{m})\right] & ; \quad 3h_b < x(\mathrm{m}) < 10h_b(\mathrm{m}) \\ \sigma_y\left\{x(\mathrm{km}) + x_y(\mathrm{km})\right\} & ; \quad x(\mathrm{m}) \geq 10h_b(\mathrm{m}) \end{cases} \qquad (2\text{-}31)$$

with the lateral virtual distance x_y given by

$$x_y = \left(\frac{0.85h_b}{p}\right)^{1/q} - 0.01h_b \qquad (2\text{-}32)$$

For h_w/h_b greater than 5 and a stack located laterally within about 2.5 h_b of the end of the building, lateral plume spread is affected by the flow around the end of the building. With end effects, the enhancement in the initial lateral spread is assumed not to exceed that given by Equation (2-29) with h_w replaced by $5h_b$. The modified σ_y equation is given by

$$\sigma_y' = \left\{\begin{array}{lcl} 1.75h_b(m) + 0.067\left[x(m) - 3h_b(m)\right] & ; & 3h_b < x(m) < 10h_b(m) \\ \sigma_y\left\{x(m) + x_y(km)\right\} & ; & x(m) \geq 10h_b(m) \end{array}\right\} \qquad (2\text{-}33)$$

$$x_y = \left(\frac{2.25h_b}{p}\right)^{1/q} - 0.01h_b \qquad (2\text{-}34)$$

The upper and lower bounds of the concentrations that can be expected to occur near a building are determined respectively by Equations (2-31) and (2-33). The user must specify whether Equation (2-31) or Equation (2-33) is to be used in the model calculations. In the absence of user instructions, the ISC Model uses Equation (2-31) if the building width to building height ratio h_w/h_b exceeds 5.

Although Equation (2-31) provides the highest concentration estimates for squat buildings with building width to building height ratios

h_w/h_b greater than 5, the equation is applicable only to a stack located near the center of the building when the wind direction is perpendicular to the long side of the building (i.e., when the air flow over the portion of the building containing the source is two dimensional). *Thus, Equation (2-33) generally is more appropriate than Equation (2-31).* It is believed that Equations (2-31) and (2-33) provide reasonable limits on the extent of the lateral enhancement of dispersion and that these equations are adequate until additional data are available to evaluate the flow near very wide buildings.

The modified σ_y equation for a tall building is given by

$$\sigma_y' = \begin{cases} 0.35h_w(m) + 0.067\left[x(m) - 3h_w\right]; & 3h_w < x(m) < 10h_w \\ \sigma_y\left\{x(km) + x_y(km)\right\} & ; \quad x(m) \geq 10h_w \end{cases} \tag{2-35}$$

$$x_y = \left(\frac{0.85h_w}{p}\right)^{1/q} - 0.01h_w \tag{2-36}$$

Because the Pasquill-Gifford σ_y and σ_z curves begin at a downwind distance of 100 meters, the ISC Model programs print a warning message and do not calculate concentrations for any source-receptor combination where the source-receptor separation is less than the maximum of 100 meters or $3h_b$ for a squat building or $3h_w$ for a tall building. It should be noted that, for certain combinations of stability and building height and/or width, the vertical and/or lateral plume dimensions indicated for a point source by the Pasquill-Gifford curves at a downwind distance of ten building heights or widths can exceed the values given by Equation (2-24) or (2-25) and by Equation (2-29), (2-31) or (2-32). Consequently, the ISC Model programs do not permit the virtual distances x_y and x_z to be less than zero.

It is important to note that the use of a single effective building width h_w for all wind directions is a simplification that is required to enable the ISC Model computer programs to operate within the constraints imposed on the programs without sacrificing other desired ISC Model features. The effective building width h_w affects σ_z for tall buildings $(h_w < h_b)$ and σ_y for squat buildings $(h_w \geq h_b)$ with plume height to building height ratios less than or equal to 1.2. Tall buildings typically have lengths and widths that are equivalent so that the use of one value of h_w for all wind directions does not significantly affect the accuracy of the calculations. However, the use of one value of h_w for squat buildings with plume height to building height ratios less than or equal to 1.2 affects the accuracy of the calculations near the source if the building length is large in comparison with the building width. For example, if the building height and width are approximately the same and the building length is equal to five building widths, the ISC Model at a downwind distance of $10h_b$ underestimates the centerline concentration or deposition by about 40 percent for winds parallel to the building's long side and overestimates the centerline concentration (or deposition) by about 60 percent for winds normal to the building's long side. Thus, the user should exercise caution in interpreting the results of concentration (or deposition) calculations for receptors located near a squat building if the stack height to building height ratio is less than or equal to 1.2.

The recommended procedure for calculating accurate concentration (or deposition) values for receptors located near squat buildings consists of two phases. First, the appropriate ISC Model program is executed using the effective building width h_w derived from the building length and width. Second, the ISC Model calculations are repeated for the receptors near the source with highest calculated concentration (or deposition) values using receptor-specific values of h_w. For example, assume that the ISCST program is used with a year of sequential hourly data to calculate maximum 24-hour average concentrations and that the highest calculated concentrations occur at Receptor A on Julian Day 18 and at Receptor B on Julian Day 352. The crosswind building width h_w associated with the wind directions required to transport emissions to Receptors A and B may be obtained from a scale drawing of the building. The ISCST program is then executed for Receptor A only on Day 18 only using the appropriate h_w value for Receptor A. Similarly, the ISCST program is executed for Receptor B only on Day 352 only using the appropriate h_w value for Receptor B.

2.4.1.2 The Vertical Term

a. The Vertical Term for Gases and Small Particulates. In general, the effects on ambient concentrations of gravitational settling and dry deposition can be neglected for gaseous pollutants and small particulates (diameters less than about 20 micrometers). The Vertical Term is then given by

$$\{\text{Vertical Term}\} = \left\{\exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right] + \sum_{i=1}^{\infty}\left[\exp\left[-\frac{1}{2}\left(\frac{2iH_m - H}{\sigma_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{2iH_m + H}{\sigma_z}\right)^2\right]\right]\right\} \quad (2\text{-}37)$$

where

H = effective stack height = sum of actual stack height h (m) and buoyant rise Δh (m)

H_m = mixing height (m)

The infinite series term in Equation (2-37) accounts for the effects of the restriction on vertical plume growth at the top of the surface mixing layer. As shown by Figure 2-4, the method of image sources is used to account for multiple reflections of the plume from the ground surface and at the top of the surface mixing layer. It should be noted that, if the effective stack height H exceeds the mixing height H_m, the plume is assumed to remain elevated and the ground-level concentration is set equal to zero.

Equation (2-37) assumes that the mixing height in rural and urban areas is known for all stability categories. As explained below, the meteorological preprocessor program uses mixing heights derived from twice-daily mixing heights calculated using the Holzworth (1972) procedures. These mixing heights are believed to be representative, at least on the average, of mixing heights in urban areas under all stabilities and of mixing heights in rural areas during periods of unstable or neutral stability. However, because the Holzworth minimum mixing heights are intended to include the heat island effect for urban areas, their applicability to rural areas during periods of stable meteorological conditions (E or F stability) is questionable. Consequently, the ISC Model in the Rural Mode currently deletes the infinite series term in Equation (2-37) for the E and F stability categories.

The Vertical Term defined by Equation (2-37) changes the form of the vertical concentration distribution from Gaussian to rectangular (uniform concentration within the surface mixing layer) at long downwind

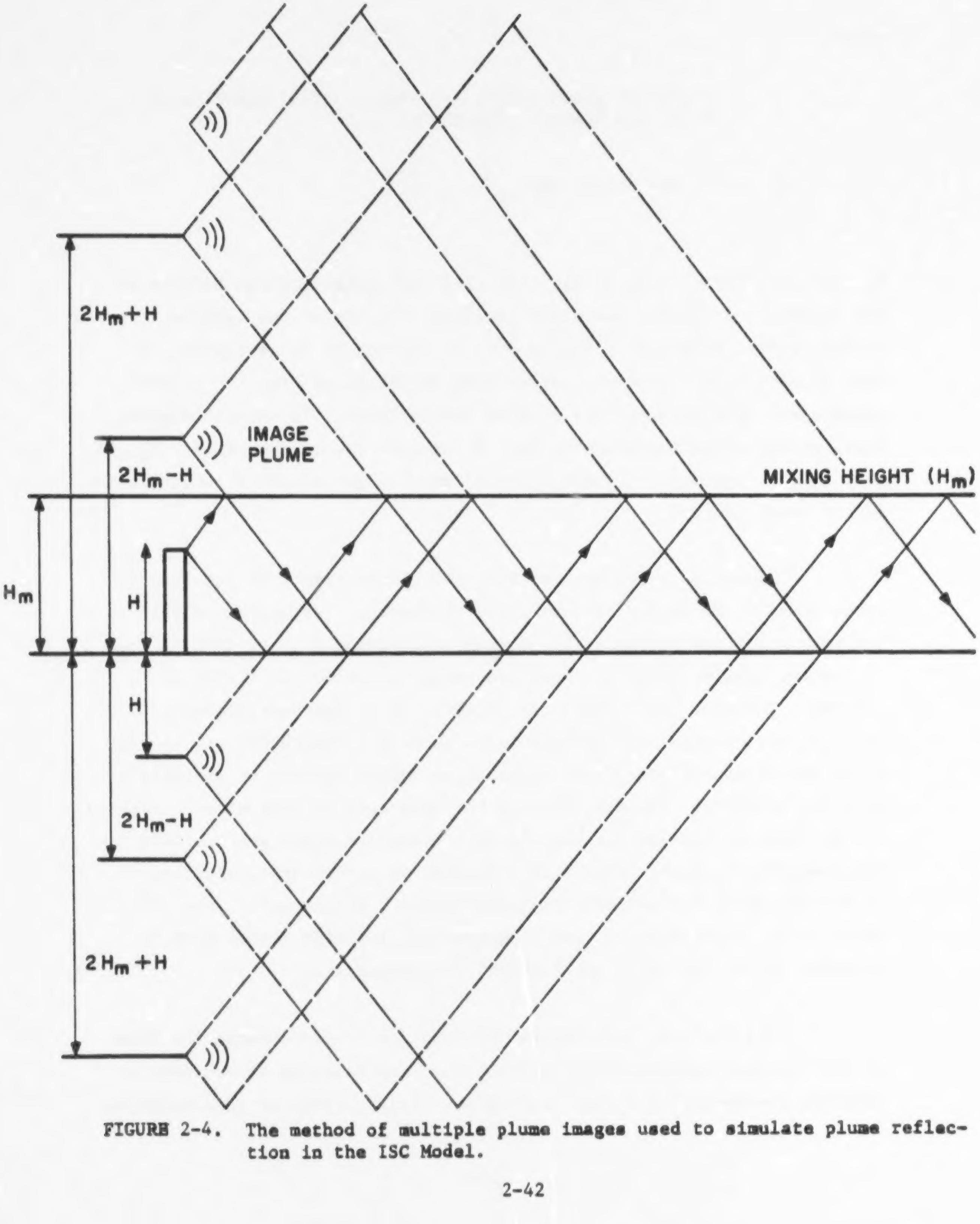

2 Hm+H
IMAGE PLUME
2 Hm-H
MIXING HEIGHT (Hm)
Hm
H
H
2 Hm-H
2 Hm +H

FIGURE 2-4. The method of multiple plume images used to simulate plume reflection in the ISC Model.

distances. Consequently, in order to reduce computational time without a loss of accuracy, Equation (2-12) is changed to the form

$$\chi \{x,y\} = \frac{KQ}{\sqrt{2\pi}\ \bar{u}\{h\}\sigma_y\ H_m} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\{\text{Decay Term}\} \qquad (2\text{-}38)$$

at downwind distances where the σ_z/H_m ratio is greater than or equal to 1.6.

The meteorological preprocessor program used by the ISC short-term model (see Appendix G) uses an interpolation scheme to assign hourly rural or urban mixing heights on the basis of the early morning and afternoon mixing heights calculated using the Holzworth (1972) procedures. The procedures used to interpolate hourly mixing heights in urban and rural areas are illustrated in Figure 2-5, where

$H_m\{max\}$ = maximum mixing height on a given day

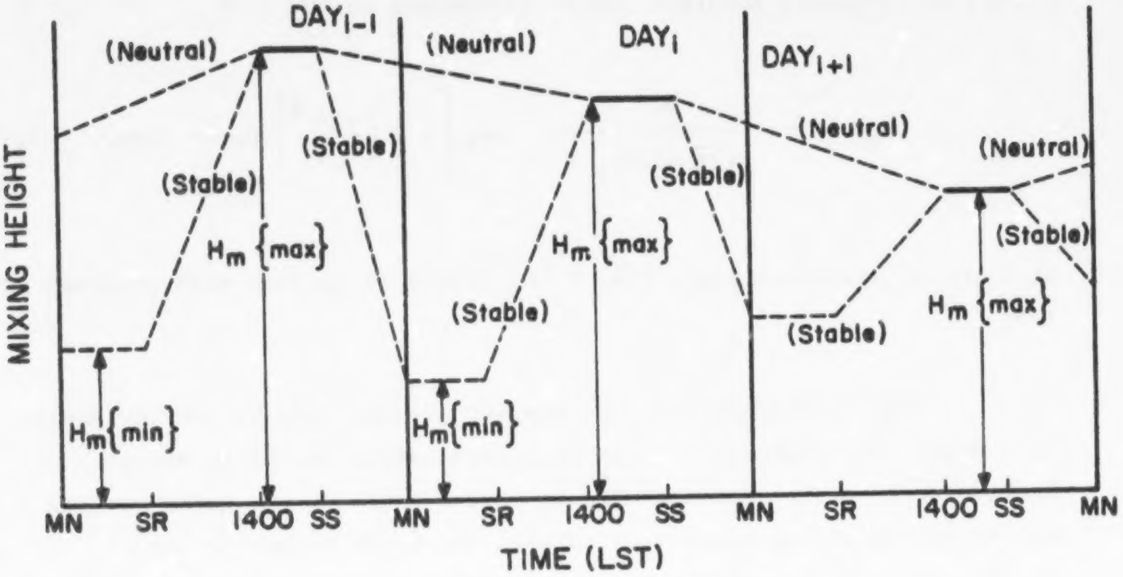
$H_m\{min\}$ = minimum mixing height on a given day

MN = midnight

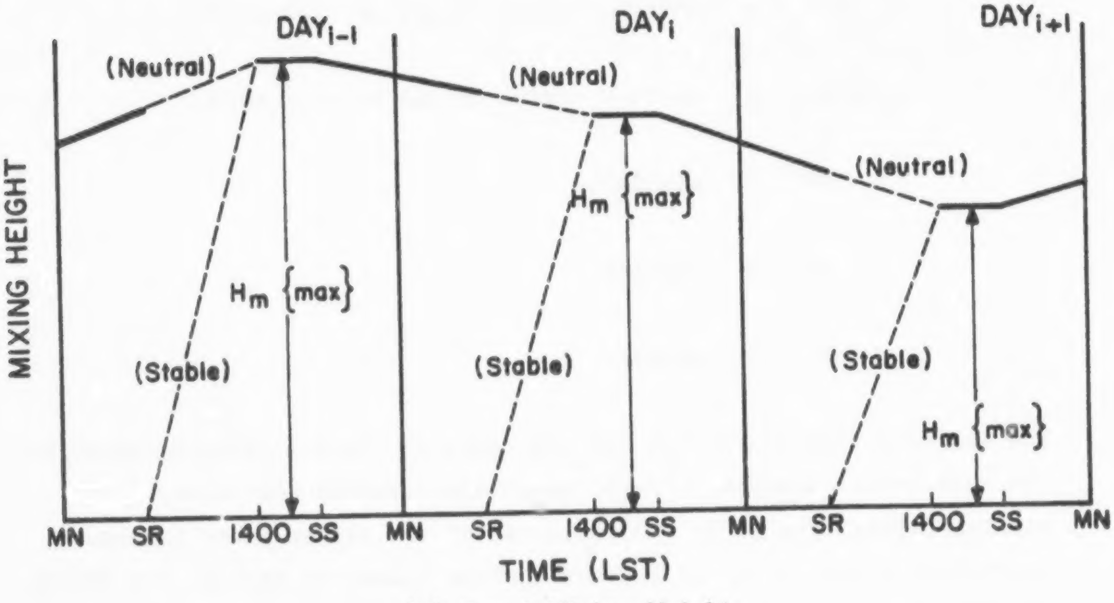
SR = sunrise

SS = sunset

The interpolation procedures are functions of the stability category for the hour before sunrise. If the hour before sunrise is neutral, the mixing heights that apply are indicated by the dashed lines labeled neutral in Figure 2-5. If the hour before sunset is stable, the mixing heights that apply are indicated by the dashed lines labeled stable. It should be pointed out that there is a discontinuity in the rural mixing


MIXING HEIGHT
DAY$_{i-1}$
DAY$_i$
DAY$_{i+1}$
(Neutral)
(Neutral)
(Neutral)
(Neutral)
(Stable)
(Stable)
(Stable)
(Stable)
(Stable)
(Stable)
(Stable)
H_m {max}
H_m {max}
H_m {max}
H_m {min}
H_m {min}
MN
SR
1400
SS
MN
SR
1400
SS
MN
SR
1400
SS
MN
TIME (LST)

(a) Urban Mixing Heights


MIXING HEIGHT
DAY$_{i-1}$
DAY$_i$
DAY$_{i+1}$
(Neutral)
(Neutral)
(Neutral)
(Stable)
(Stable)
(Stable)
H_m {max}
H_m {max}
H_m {max}
MN
SR
1400
SS
MN
SR
1400
SS
MN
SR
1400
SS
MN
TIME (LST)

(b) Rural Mixing Heights

FIGURE 2-5. Schematic illustration of (a) urban and (b) rural mixing height interpolation procedures.

height at sunrise if the preceding hour is stable. As explained above, because of the uncertainties about the applicability of Holzworth mixing heights to rural areas during periods of E and F stability, the ISC Model in the Rural Mode ignores the interpolated mixing heights for E and F stabilities and effectively sets the mixing height equal to infinity.

b. The Vertical Term in Complex Terrain. The ISC Model makes the following assumption about plume behavior in complex terrain:

- The plume axis remains at the plume stabilization height above mean sea level as it passes over elevated terrain
- The mixing height is terrain following
- The wind speed is a function of height above the surface (see Equation (2-10))

Thus, a modified plume stabilization height H' is substituted for the effective stack height H in the Vertical Term given by Equation (2-37). For example, the effective plume stabilization height at the point (X, Y) is given by

$$H' \{X,Y\} = h + \Delta h + z_s - z \{X,Y\} \tag{2-39}$$

where

z_s = height above mean sea level of the base of the stack

$z \{X,Y\}$ = height above mean sea level of the point (X,Y)

It should be noted that, if the terrain height $(z\{X,Y\} - z_s)$ exceeds h for a stack or H for a volume source (See Section 2.4.2), the computer program prints an error message and terminates execution. Also, if the receptor elevation is less than the stack base elevation, the receptor elevation is set equal to the stack base elevation by the computer program. Figure 2-6 illustrates the terrain-adjustment procedures used by the ISC Model.

c. The Vertical Term for Large Particulates. The dispersion of particulates or droplets with significant gravitational settling velocities differs from that of gaseous pollutants and small particulates in that the larger particulates are brought to the surface by the combined processes of atmospheric turbulence and gravitational settling. Additionally, gaseous pollutants and small particulates tend to be reflected from the surface, while larger particulates that come in contact with the surface may be completely or partially retained at the surface. The ISC Model Vertical Term for large particulates includes the effects of both gravitational settling and dry deposition. Gravitational settling is assumed to result in a tilted plume with the plume axis inclined to the horizontal at an angle given by $\arctan (V_s/\bar{u})$ where V_s is the gravitational settling velocity. A user-specified fraction γ of the material that reaches the ground surface by the combined processes of gravitational settling and atmospheric turbulence is assumed to be reflected from the surface. Figure 2-7 illustrates the vertical concentration profiles for complete reflection from the surface (γ equal to unity), 50-percent reflection from the surface (γ equal to 0.5) and complete retention at the surface (γ equal to zero).

For a given particulate source, the user must subdivide the total particulate emissions into N settling-velocity categories (the maximum value of N is 20). The ground-level concentration of particulates with settling velocity V_{sn} is given by Equation (2-12) with the Vertical Term defined as (Dumbauld and Bjorklund, 1975)

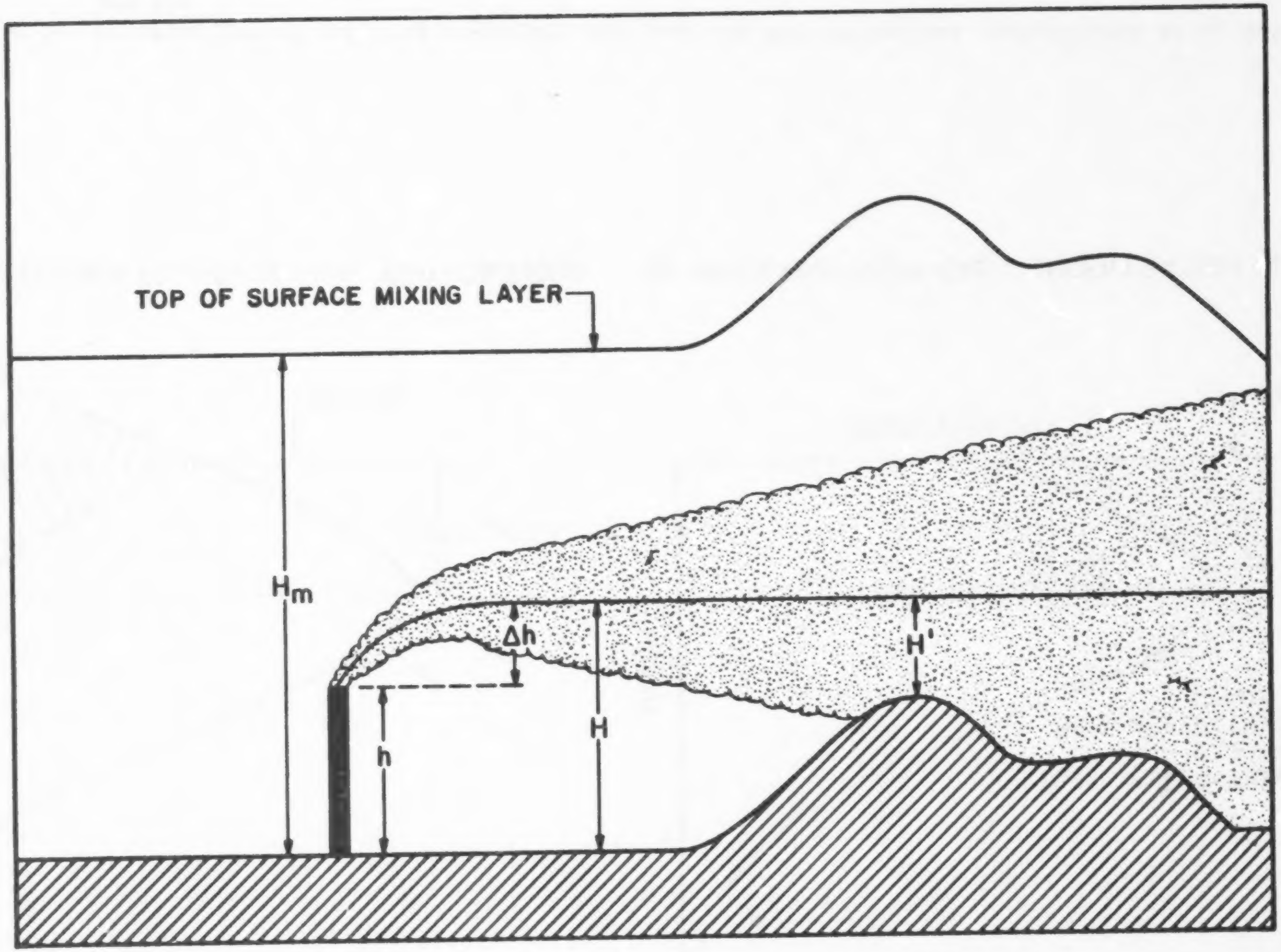
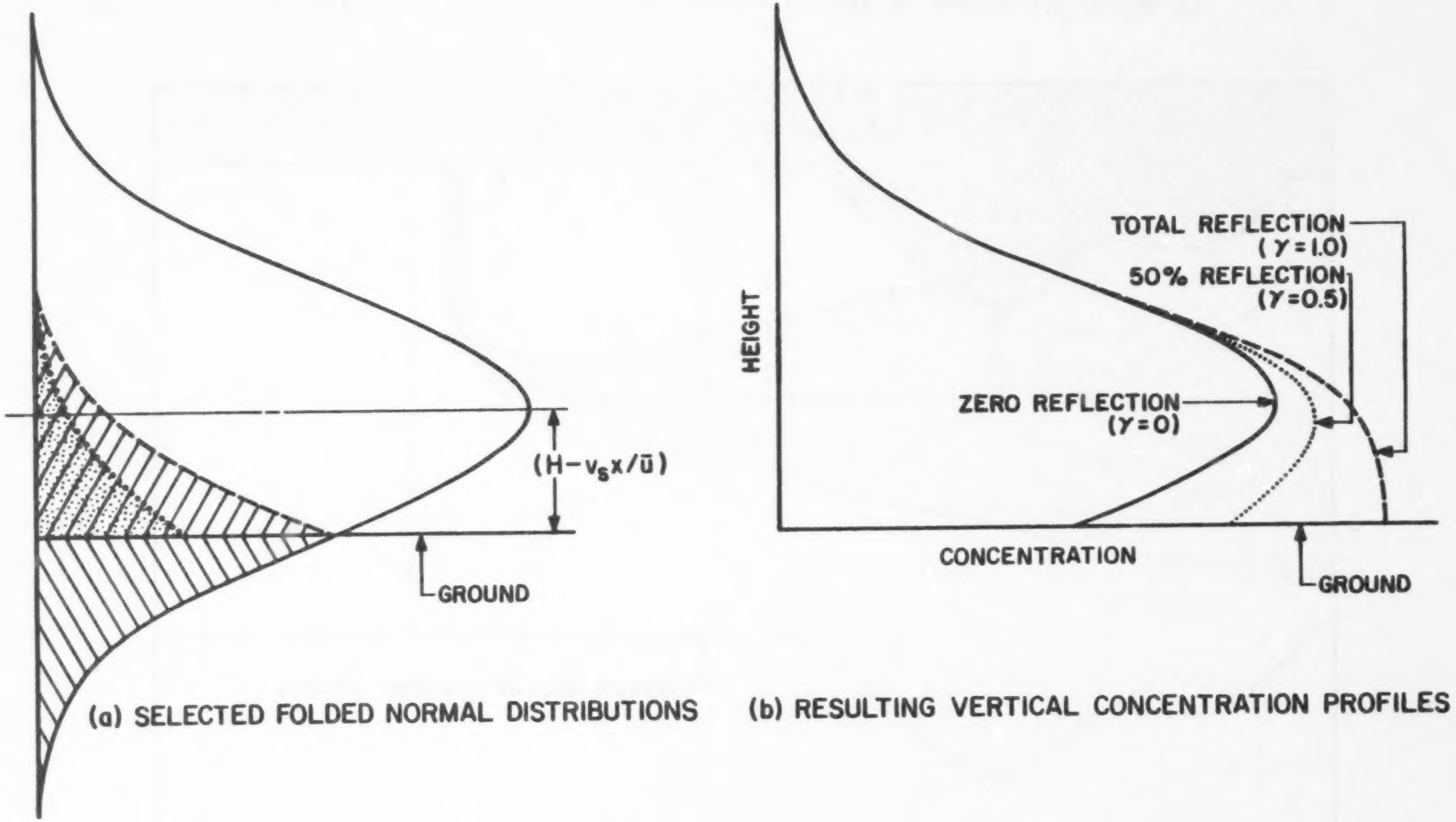

TOP OF SURFACE MIXING LAYER
H_m
Δh
h
H
H'

FIGURE 2-6. Illustration of plume behavior in complex terrain assumed by the ISC Model.


(H−v_sx/ū)
GROUND
HEIGHT
TOTAL REFLECTION (γ=1.0)
50% REFLECTION (γ=0.5)
ZERO REFLECTION (γ=0)
CONCENTRATION
GROUND

(a) SELECTED FOLDED NORMAL DISTRIBUTIONS

(b) RESULTING VERTICAL CONCENTRATION PROFILES

FIGURE 2-7. Illustration of vertical concentration profiles for reflection coefficients of 0, 0.5 and 1.0.

$$\{\text{Vertical Term}\} = \frac{\phi_n}{2}\left\{\sum_{i=0}^{\infty}\left[\gamma_n^i \exp\left[-\frac{1}{2}\left(\frac{2iH_m - H + (V_{sn}x/\bar{u}\{h\})}{\sigma_z}\right)^2\right]\right.\right.$$

$$\left.+ \gamma_n^{i+1} \exp\left[-\frac{1}{2}\left(\frac{2iH_m + H - (V_{sn}x/\bar{u}\{h\})}{\sigma_z}\right)^2\right]\right]$$

$$+ \sum_{i=1}^{\infty}\left[\gamma_n^i \exp\left[-\frac{1}{2}\left(\frac{2iH_m + H - (V_{sn}x/\bar{u}\{h\})}{\sigma_z}\right)^2\right]\right. \qquad (2\text{-}40)$$

$$\left.\left.+ \gamma_n^{i-1} \exp\left[-\frac{1}{2}\left(\frac{2iH_m - H + (V_{sn}x/\bar{u}\{h\})}{\sigma_z}\right)^2\right]\right]\right\}$$

where

ϕ_n = mass fraction of particulates in the n^{th} settling-velocity category

γ_n = reflection coefficient for particulates in the n^{th} settling-velocity category (set equal to unity for complete reflection)

V_{sn} = settling velocity of particulates in the n^{th} settling-velocity category

For convenience, 0^0 is defined to be unity in Equation (2-40). The total concentration is computed by the program by summing over the N settling-velocity categories. The optional algorithm used to calculate dry deposition is discussed in Section 2.4.3.

Use of Equation (2-40) requires a knowledge of both the particulate size distribution and the density of the particulates emitted by each source. The total particulate emissions for each source are subdivided by the user into a maximum of 20 categories and the gravitational settling velocity is calculated for the mass-mean diameter of each category. The mass-mean diameter is given by

$$\bar{d} = \left[\frac{d_2^3 + d_1^2 d_2 + d_1 d_2^2 + d_1^3}{4}\right]^{1/3} \qquad (2\text{-}41)$$

where d_1 and d_2 are the lower and upper bounds of the particle-size category. McDonald (1960) gives simple techniques for calculating the gravitational settling velocity for all sizes of particulates. For particulates with a density on the order of 1 gram per cubic centimeter and diameters less than about 80 micrometers, the settling velocity is given by

$$V_s = \frac{2\rho g r^2}{9\mu} \qquad (2\text{-}42)$$

where

V_s = settling velocity ($cm \cdot sec^{-1}$)

ρ = particle density ($gm \cdot cm^{-3}$)

g = acceleration due to gravity ($980\ cm \cdot sec^{-2}$)

r = particle radius (cm)

μ = absolute viscosity of air ($\mu \sim 1.83 \times 10^{-4}\ gm \cdot cm^{-1} \cdot sec^{-1}$)

It should be noted that the settling velocity calculated using Equation (2-42) must be converted by the user from centimeters per second to meters per second for use in the model calculations.

The reflection coefficient γ_n can be estimated for each particle-size category using Figure 2-8 and the settling velocity calculated for the mass-mean diameter. If it is desired to include the effects of gravitational settling in calculating ambient particulate concentrations while at the same time excluding the effects of deposition, γ_n should be set equal to unity for all settling velocities. On the other hand, if it is desired to calculate maximum possible deposition, γ_n should be set equal to zero for all settling velocities. The effects of dry deposition for gaseous pollutants may be estimated by setting the settling velocity V_{sn} equal to zero and the reflection coefficient γ_n equal to the amount of material assumed to be reflected from the surface. For example, if 20 percent of a gaseous pollutant that reaches the surface is assumed to be retained at the surface by vegetation uptake or other mechanisms, γ_n is equal to 0.8.

The derivation of Equation (2-40) assumes that the terrain is flat or gently rolling. Consequently, the gravitational settling and dry deposition options cannot be used for sources located in complex terrain without violating mass continuity. However, the effects of gravitational settling alone can be estimated for sources located in complex terrain by setting γ_n equal to unity for each settling velocity category. This procedure will tend to overestimate ground-level concentrations, especially at the longer downwind distances, because it neglects the effects of dry deposition.

It should be noted that Equation (2-40) assumes that σ_z is a continuous function of downwind distance. Also, Equation (2-40) does not simplify for σ_z/H_m greater than 1.6 as does Equation (2-37). As shown by Table 2-8, σ_z for the very unstable A stability category attains a maximum value of 5,000 meters at 3.11 kilometers. Because Equation (2-40) requires that σ_z be a continuous function of distance, the coefficients a and b given in Table 2-8 for A stability and the 0.51- to 3.11-kilometer range are used by the ISC Model in calculations beyond 3.11 kilometers. Consequently, this introduces uncertainties in the results of the calculations beyond 3.11 kilometers for A stability.

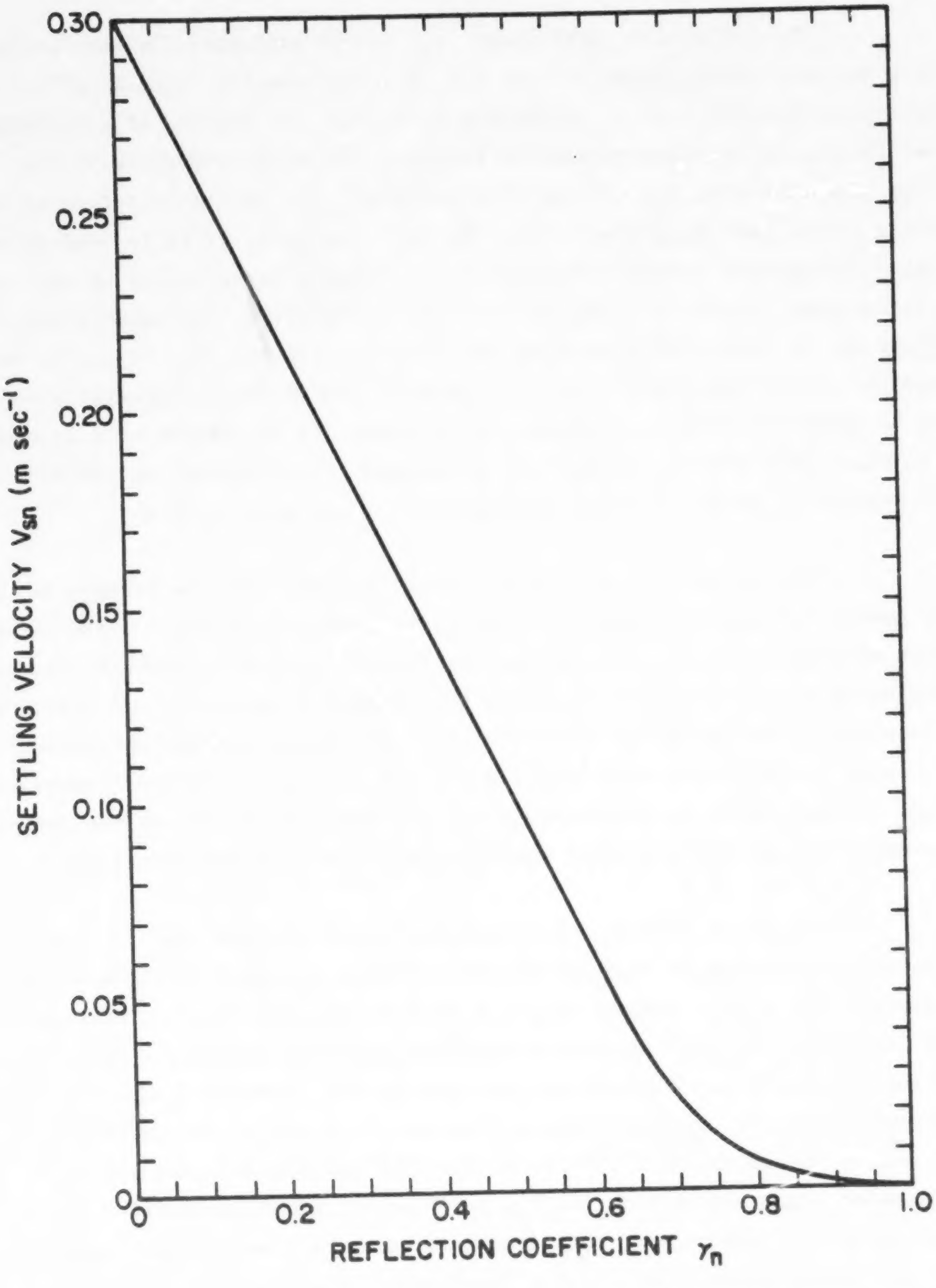


FIGURE 2-8. Relationship between the gravitational settling velocity V_{sn} and the reflection coefficient γ_n suggested by Dumbauld, et al. (1976).

2.4.2 Area, Volume and Line Source Emissions

2.4.2.1 General

The area and volume sources options of the ISC Model are used to simulate the effects of emissions from a wide variety of industrial sources. In general, the ISC area source model is used to simulate the effects of fugitive emissions from sources such as storage piles and slag dumps. The ISC volume source model is used to simulate the effects of emissions from sources such as building roof monitors and line sources (for example, conveyor belts and rail lines).

2.4.2.2 The Short-Term Area Source Model

The ISC area source model is based on the equation for a finite crosswind line source. Individual area sources are required to have the same north-south and east-west dimensions. However, as shown by Figure 2-9, the effects of an area source with an irregular shape can be simulated by dividing the area source into multiple squares that approximate the geometry of the area source. Note that the size of the individual area sources in Figure 2-9 varies; the only requirement is that each area source must be square. The ground-level concentration at downwind distance x (measured from the downwind edge of the area source) and crosswind distance y is given by

$$\chi\{x,y\} = \frac{KQ_A\, x_o}{\sqrt{2\pi}\,\bar{u}\{h\}\,\sigma_z}\left\{\text{Vertical Term}\right\}\left\{\text{erf}\left(\frac{x_o'/2 + y}{\sqrt{2}\,\sigma_y}\right) + \text{erf}\left(\frac{x_o'/2 - y}{\sqrt{2}\,\sigma_y}\right)\right\}\left\{\text{Decay Term}\right\} \qquad (2\text{-}43)$$

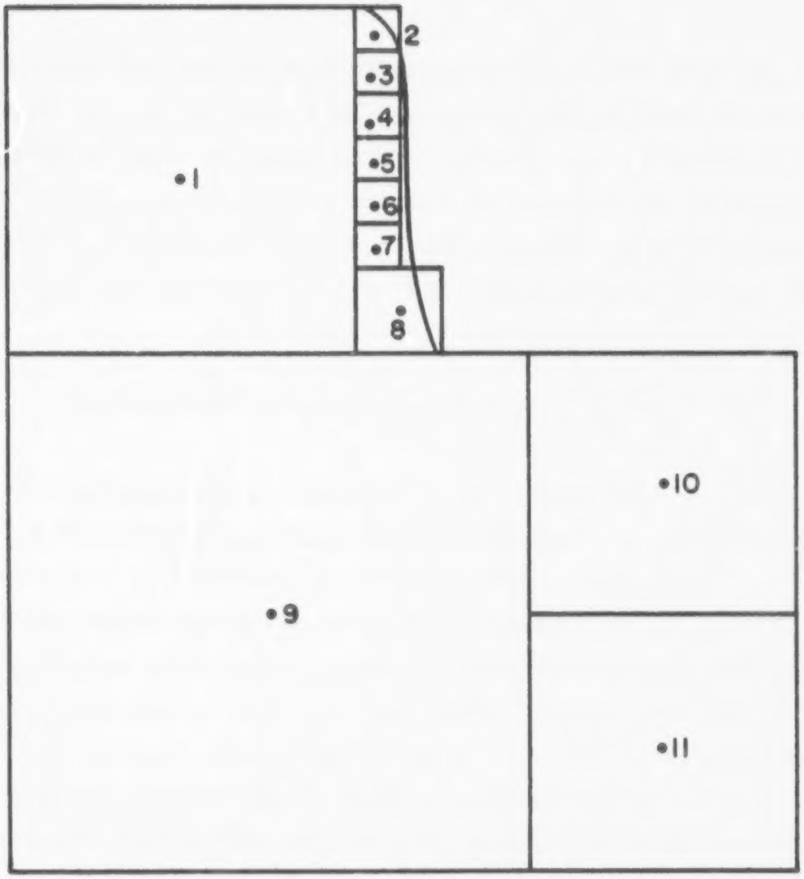

1
2
3
4
5
6
7
8
9
10
11

FIGURE 2-9. Representation of an irregularly shaped area source by 11 square area sources.

where

Q_A = area source emission rate (mass per unit area per unit time)

x_o = length of the side of the area source (m)

x_o' = effective crosswind width = $2x_o/\sqrt{\pi}$

and the Vertical Term is given by Equation (2-37) or Equation (2-40) with the effective emission height H assigned by the user. In general, H should be set equal to the physical height of the source of fugitive emissions. For example, the emission height H of a slag dump is the physical height of the slag dump. A vertical virtual distance, given by x_o in kilometers, is added to the actual downwind distance x for the σ_z calculations. If a receptor is located within $x_o'/2$ plus 100 meters of the center of an area source, a warning message is printed and no concentrations are calculated for the source-receptor combination. However, program execution is not terminated.

It is recommended that, if the separation between an area source and a receptor is less than the side of the area source x_o, the area source be subdivided into smaller area sources. If the source-receptor separation is less than x_o, the ISC Model tends to overpredict the area source concentration. The degree of overprediction is a function of stability, the orientation of the receptor with respect to the area source and the mean wind direction. However, the degree of overprediction near the area source rarely exceeds about 30 percent.

2.4.2.3 The Short-Term Volume Source Model

Equation (2-12) is also used to calculate ground-level concentrations produced by volume-source emissions. If the volume source is elevated, the user assigns the emission height H. The user also assigns initial lateral (σ_{yo}) and vertical (σ_{zo}) dimensions for the volume source.

Lateral (x_y) and vertical (x_z) virtual distances are added to the actual downwind distance x for the σ_y and σ_z calculations. The lateral virtual distance in kilometers is given by Equation (2-22). Similarly, the vertical virtual distance in kilometers is given by Equation (2-23).

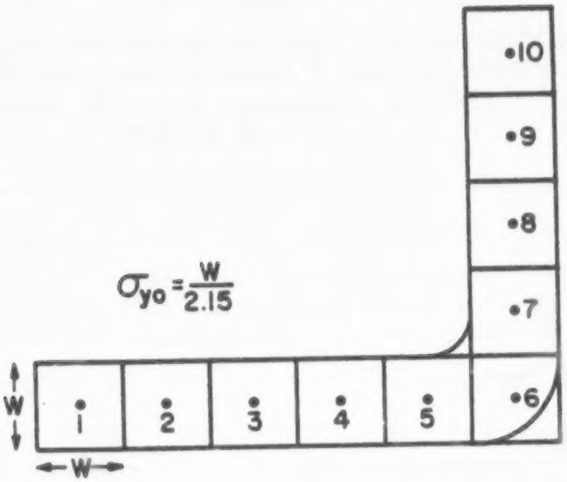
The volume source model is used to simulate the effects of emissions from sources such as building roof monitors and line sources (for example, conveyor belts and rail lines). As with the area source model, the north-south and east-west dimensions of each volume source used in the model must be the same. Table 2-10 summarizes the general procedures suggested for estimating initial lateral (σ_{yo}) and vertical (σ_{zo}) dimensions for single volume sources and for multiple volume sources used to represent a line source. In the case of a long and narrow line source such as a rail line, it may not be practical to divide the source into N volume sources, where N is given by the length of the line source divided by its width. The user can obtain an approximate representation of the line source by placing a smaller number of volume sources at equal intervals along the line source. In general, the spacing between individual volume sources should not be greater than twice the width of the line source. However, a larger spacing can be used if the ratio of the minimum source-receptor separation and the spacing between individual volume sources is greater than about 3. In these cases, concentrations at the nearest receptors may be underestimated by 10 to 15 percent. At longer downwind distances, concentrations calculated using fewer than N volume sources to represent the line source converge to the concentrations calculated using N volume sources to represent the line source as long as sufficient volume sources are used to preserve the horizontal geometry of the line source.

Figure 2-10 illustrates representations of a curved line source by multiple volume sources. Emissions from a line source or narrow volume source represented by multiple volume sources are divided equally

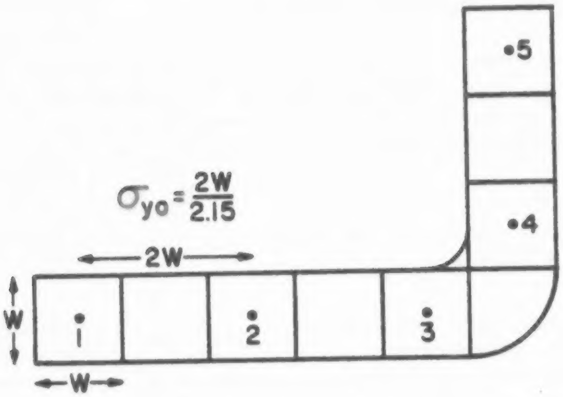
TABLE 2-10

SUMMARY OF SUGGESTED PROCEDURES FOR ESTIMATING INITIAL LATERAL DIMENSIONS (σ_{yo}) AND INITIAL VERTICAL DIMENSIONS (σ_{zo}) FOR VOLUME AND LINE SOURCES

Type of Source	Procedure for Obtaining Initial Dimension
(a) Initial Lateral Dimensions (σ_{yo})	
Single Volume Source	σ_{yo} = length of side divided by 4.3
Line Source Represented by Adjacent Volume Sources (see Figure 2-10(a))	σ_{yo} = length of side divided by 2.15
Line Source Represented by Separated Volume Sources (see Figure 2-10(b))	σ_{yo} = center to center distance divided by 2.15
(b) Initial Vertical Dimensions (σ_{zo})	
Surface-Based Source ($H \approx 0$)	σ_{zo} = vertical dimension of source divided by 2.15
Elevated Source ($H>0$) on or Adjacent to a Building	σ_{zo} = building height divided by 2.15
Elevated Source ($H>0$) not on or Adjacent to a Building	σ_{zo} = vertical dimension of source divided by 4.3


$\sigma_{yo} = \frac{W}{2.15}$
W
W
1
2
3
4
5
6
7
8
9
10

(a) EXACT REPRESENTATION


$\sigma_{yo} = \frac{2W}{2.15}$
2W
W
W
1
2
3
4
5

(b) APPROXIMATE REPRESENTATION

FIGURE 2-10. Exact and approximate representations of a line source by multiple volume sources.

among the individual sources unless there is a known spatial variation in emissions. Setting the initial lateral dimension σ_{yo} equal to W/2.15 in Figure 2-10(a) or 2W/2.15 in Figure 2-10(b) results in overlapping Gaussian distributions for the individual sources. If the wind direction is normal to a straight line source that is represented by multiple volume sources, the initial crosswind concentration distribution is uniform except at the edges of the line source. The doubling of σ_{yo} by the user in the approximate line-source representation in Figure 2-10(b) is offset by the fact that the emission rates for the individual volume sources are also doubled by the user.

There are two types of volume sources: surface-based sources, which may also be modeled as area sources, and elevated sources. An example of a surface-based source is a surface rail line. The effective emission height H for a surface-based source is usually set equal to zero. An example of an elevated source is an elevated rail line with an effective emission height H set equal to the height of the rail line.

2.4.3 The ISC Short-Term Dry Deposition Model

2.4.3.1 General

The Industrial Source Complex short-term dry deposition model is based on the Dumbauld, et al. (1976) deposition model. The Dumbauld, et al. model, which is an advanced version of the Cramer, et al. (1972) deposition model, assumes that a user-specified fraction γ_n of the material that comes into contact with the ground surface by the combined processes of atmospheric turbulence and gravitational settling is reflected from the surface (see Section 2.4.1.2.c). The reflection coefficient γ_n, which is a function of settling velocity and the ground surface for particulates and of the ground surface for gaseous pollutants, is analogous in purpose to the deposition velocity used in other deposition models. The Cramer, et al. (1972) deposition model has closely matched ground-level deposition patterns for droplets with diameters above about 30 micrometers, while the more generalized Dumbauld, et al. (1976) deposition model has closely matched observed deposition patterns for both large and small droplets.

Section 2.4.1.2.c discusses the selection of the reflection coefficient γ_n as well as the computation of the gravitational settling velocity V_{sn}. The ISC dry deposition model should not be applied to sources located in complex terrain. Also, as noted in Section 2.4.1.2.c, uncertainties in the deposition calculations are likely for the A stability category if deposition calculations are made at downwind distances greater than 3.11 kilometers. Deposition and ambient concentration calculations cannot be made in a single program execution. In an individual computer run, the ISC Model calculates either concentration (including the effects of gravitational settling and dry deposition) or dry deposition.

2.4.3.2 Stack and Volume Source Emissions

Deposition for particulates in the n^{th} settling-velocity category or a gaseous pollutant with zero settling velocity V_{sn} and a reflection coefficient γ_n is given by

$$\begin{aligned} DEP_n\{x,y\} = {} & \frac{KQ_\tau\ (1 - \gamma_n)\phi_n}{2\pi\ \sigma_y\ \sigma_z\ x} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \exp\left[-\psi\ x/\bar{u}\{h\}\right] \\ & \left\{\left[\bar{b}H + (1 - \bar{b})\ V_{sn}\ x/\bar{u}\{h\}\right] \exp\left[-\frac{1}{2}\left(\frac{H - V_{sn}\ x/\bar{u}\{h\}}{\sigma_z}\right)^2\right]\right. \qquad (2\text{-}44) \\ & + \sum_{i=1}^{\infty}\left[\gamma^{i-1}\left[\bar{b}\ (2iH_m - H) - (1 - b)\ V_{sn}\ x/\bar{u}\{h\}\right]\right. \end{aligned}$$

(Equation (2-44) continued on following page)

(Equation (2-44) continued)

$$\exp\left[-\frac{1}{2}\left(\frac{2iH_m - H + V_{sn}x/\bar{u}\{h\}}{\sigma_z}\right)^2\right]$$

$$+ \gamma^i \left[\bar{b}\left(2iH_m + H\right) + \left(1 - \bar{b}\right) V_{sn}x/\bar{u}\{h\}\right] \qquad (2\text{-}44)$$

$$\left.\left.\exp\left[-\frac{1}{2}\left(\frac{2iH_m + H - V_{sn}x/\bar{u}\{h\}}{\sigma_z}\right)^2\right]\right]\right\}$$

The parameter Q_τ is the total amount of material emitted during the time period τ for which the deposition calculation is made. For example, Q_τ is the total amount of material emitted during a 1-hour period if an hourly deposition is calculated. For time periods longer than an hour, the program sums the deposition calculated for each hour to obtain the total deposition. For convenience, 0^0 is defined to be unity in Equation (2-44). The coefficient $\bar{b}$ is the average value of the exponent b for the interval between the source and the downwind distance x (see Table 2-8). In the case of a volume source, the user must specify the effective emission height H and the initial source dimensions σ_{yo} and σ_{zo}.

2.4.3.3. Area Source Emissions

For area source emissions, the first line of Equation (2-44) is changed to the form

$$DEP_n\{x,y\} = \frac{KQ_{A\tau}\, x_o\, (1 - \gamma_n)\, \phi_n}{\sqrt{2\pi}\, \sigma_z\, x} \left\{ \mathrm{erf}\left(\frac{x_o'/2 + y}{\sqrt{2}\, \sigma_y}\right) + \mathrm{erf}\left(\frac{x_o'/2 - y}{\sqrt{2}\, \sigma_y}\right) \right\} \exp\left[-\psi\, x/\bar{u}\{h\}\right] \qquad (2\text{-}45)$$

The parameter $Q_{A\tau}$ is the total mass per unit area emitted over the time period τ for which deposition is calculated.

2.5 THE ISC LONG-TERM DISPERSION MODEL EQUATIONS

2.5.1 Stack Emissions

The ISC long-term concentration model makes the same basic assumptions as the short-term model. In the long-term model, the area surrounding a continuous source of pollutants is divided into sectors of equal angular width corresponding to the sectors of the seasonal and annual frequency distributions of wind direction (see Figure 2-1). Seasonal or annual emissions from the source are partitioned among the sectors according to the frequencies of wind blowing toward the sectors. The ground-level concentration fields calculated for each source are translated to a common coordinate system (either polar or Cartesian as specified by the user) and summed to obtain the total due to all sources.

For a single stack, the mean seasonal concentration at a point ($r > 100$ m, Θ) with respect to the stack is given by

$$\chi_{\ell}\{r,\Theta\} = \frac{2K}{\sqrt{2\pi}\; r\; \Delta\Theta'} \sum_{i,j,k} \left[\frac{Q_{i,k,\ell}\; f_{i,j,k,\ell}}{\bar{u}_{i,k}\{h\}\; \sigma_{z;k}} \; S\{\Theta\}\; V_{i,k,\ell} \; \exp\left[-\psi\; r/\bar{u}_{i,k}\{h\}\right]\right] \qquad (2\text{-}45)$$

where

$Q_{i,k,\ell}$ = pollutant emission rate (mass per unit time), for the i^{th} wind-speed category, k^{th} stability category and ℓ^{th} season

$f_{i,j,k,\ell}$ = frequency of occurrence of the i^{th} wind-speed category, j^{th} wind-direction category and k^{th} stability category for the ℓ^{th} season

$\Delta\Theta'$ = the sector width in radians

$S\{\Theta\}$ = a smoothing function similar to that of the AQDM (see Section 2.5.1.3)

$\bar{u}_{i,k}\{h\}$ = mean wind speed (m/sec) at stack height h for the i^{th} wind-speed category and k^{th} stability category

$\sigma_{z;k}$ = standard deviation of the vertical concentration distribution (m) for the k^{th} stability category

$V_{i,k,\ell}$ = the Vertical Term for the i^{th} wind-speed category, k^{th} stability category and ℓ^{th} season

ψ = the decay coefficient (sec^{-1})

The mean annual concentration at the point (r, Θ) is calculated from the seasonal concentrations using the expression

$$\chi_a\{r,\Theta\} = \frac{1}{4} \sum_{\ell=1}^{4} \chi_\ell\{r,\Theta\} \qquad (2\text{-}47)$$

The terms in Equation (2-46) correspond to the terms discussed in Section 2.4.1 for the short-term model except that the i subscript refers to wind-speed categories, the j subscript refers to wind-direction categories, the k subscript refers to stability categories, and the ℓ subscript refers to the season. The various terms are briefly discussed in the following subsections. In addition to stack emissions, the ISC long-term concentration model considers emissions from area and volume sources. These model options are discussed in Section 2.5.2. The optional algorithms for calculating dry deposition are discussed in Section 2.5.3.

2.5.1.1 The Dispersion Coefficients

a. Point Source Dispersion Coefficients. See Section 2.4.1.1.a for a discussion of the procedures used to calculate the standard deviation of the vertical concentration distribution σ_z for point sources (sources without initial dimensions).

b. Downwind and Crosswind Distances. See the discussion given in Section 2.4.1.1.b.

c. Vertical Virtual Distances. See Section 2.4.1.1.c for a discussion of the procedures used to calculate vertical virtual distances. The lateral virtual distance is given by

$$x_y = r_o \cot(\Delta\Theta'/2) \qquad (2\text{-}48)$$

where r_o is the effective source radius. For volume sources (see Section 2.5.2), the program sets r_o equal to 2.15 σ_{yo}, where σ_{yo} is the initial lateral dimension. For area sources (see Section 2.5.2), the program sets r_o equal to $x_o/\sqrt{\pi}$ where x_o is the side of the area source. For plumes affected by building wakes (see Section 2.4.1.1.d), the program sets r_o equal to 2.15 σ'_y where σ'_y is given for squat buildings by Equation (2-29), (2-31) or (2-33) for downwind distances between 3 and 10 building heights and for tall buildings by Equation (2-35) for downwind distances between 3 and 10 building widths. At downwind distances greater than 10 building heights for Equation (2-29), (2-31) or (2-33), σ'_y is held constant at the value of σ'_y calculated at a downwind distance of 10 building heights. Similarly, at downwind distances greater than 10 building widths for Equation (2-35), σ'_y is held constant at the value of σ'_y calculated at a downwind distance of 10 building widths.

d. Procedures Used to Account for the Effects of Building Wakes on Effluent Dispersion. With the exception of the equations used to calculate the lateral virtual distance, the procedures used to account for the effects of building wake effects on effluent dispersion are the same as those outlined in Section 2.4.1.1.d for the short-term model. The calculation of lateral virtual distances by the long-term model is discussed in Section 2.5.1.1.c above.

2.5.1.2 The Vertical Term

a. The Vertical Term for Gases and Small Particulates. The Vertical Term for gases and small particulates is given by

$$V_{i,k,\ell} = \exp\left[-\frac{1}{2}\left(\frac{H_{i,k,\ell}}{\sigma_{z;k}}\right)^2\right] - \qquad (2\text{-}49)$$

(Equation (2-49) continued on following page.)

(Equation 2-48) continued.)

$$+ \sum_{n=1}^{\infty} \left\{ \exp \left[- \frac{1}{2} \left(\frac{2nH_{m;i,k,\ell} - H_{i,k,\ell}}{\sigma_{z;k}} \right)^2 \right] \right. \tag{2-49}$$

$$\left. + \exp \left[- \frac{1}{2} \left(\frac{2nH_{m;i,k,\ell} + H_{i,k,\ell}}{\sigma_{z;k}} \right)^2 \right] \right\}$$

Except for the use of subscripts to indicate wind-speed and stability categories and season, the parameters in Equation (2-49) correspond to those discussed in Section 2.4.1.2. As shown by Equation (2-49), the user may assign a separate mixing height H_m to each combination of wind-speed and stability categories for each season.

As with the short-term model, the Vertical Term given by Equation (2-48) is changed to the form

$$V_{i,k,\ell} = \frac{\sqrt{2\pi}\ \sigma_{z;k}}{2H_{m;i,k,\ell}} \tag{2-50}$$

at downwind distances where the $\sigma_{z;k}/H_{m;i,k,\ell}$ ratio is greater than or equal to 1.6. Additionally, the ground-level concentration is set equal to zero if the effective stack height H exceeds the mixing height H_m. As explained in Section 2.2.1.2, ISCLT in the Rural Mode currently sets the mixing height equal to infinity for the E and F stability categories.

b. The Vertical Term in Complex Terrain. See Section 2.4.1.2.b.

c. The Vertical Term for Large Particulates. Section 2.4.1.2.c discusses the differences in the dispersion of large particulates and the dispersion of gases and small particulates. The Vertical Term for large particulates is given by

$$
\begin{aligned}
V_{i,k,\ell} = \frac{\phi_n}{2} \Bigg\{ \sum_{a=0}^{\infty} \Bigg[& \gamma_n^a \exp\left[-\frac{1}{2} \left(\frac{2aH_{m;i,k,\ell} - H_{i,k,\ell} + V_{sn} r/\bar{u}\{h\}}{\sigma_{z;k}} \right)^2 \right] \\
& + \gamma_n^{a+1} \exp\left[-\frac{1}{2} \left(\frac{2aH_{m;i,k,\ell} + H_{i,k,\ell} - V_{sn} r/\bar{u}_{i,k}\{h\}}{\sigma_{z;k}} \right)^2 \right] \Bigg] \\
+ \sum_{a=1}^{\infty} \Bigg[& \gamma_n^a \exp\left[-\frac{1}{2} \left(\frac{2aH_{m;i,k,\ell} + H_{i,k,\ell} - V_{sn} r/\bar{u}_{i,k}\{h\}}{\sigma_{z;k}} \right)^2 \right] \\
& + \gamma_n^{a-1} \exp\left[-\frac{1}{2} \left(\frac{2aH_{m;i,k,\ell} - H_{i,k,\ell} + V_{sn} r/\bar{u}_{i,k}\{h\}}{\sigma_{z;k}} \right)^2 \right] \Bigg] \Bigg\} .
\end{aligned}
\tag{2-51}
$$

where ϕ_n is the mass fraction of particulates with settling velocity V_{sn}, γ_n is the surface reflection coefficient and 0^0 is defined as unity. See Section 2.4.1.2.c for a discussion of the parameters in Equation (2-51) and guidance on the use of this model option.

2.5.1.3 The Smoothing Function

As shown by Equation (2-46), the rectangular concentration distribution within a given angular sector is modified by the function $S\{\Theta\}$ which smoothes discontinuities in the concentration at the boundaries of adjacent sectors. The centerline concentration in each sector is unaffected by contributions from adjacent sectors. At points off the sector centerline, the concentration is a weighted function of the concentration at the centerline and the concentration at the centerline of the nearest adjoining sector. The smoothing function is given by

$$S\{\Theta\} = \left\{ \begin{array}{ll} \dfrac{\Delta\Theta' - \left|\Theta_j' - \Theta'\right|}{\Delta\Theta'} & ; \left|\Theta_j' - \Theta'\right| \leq \Delta\Theta' \\ \\ 0 & ; \left|\Theta_j' - \Theta'\right| > \Delta\Theta' \end{array} \right\} \qquad (2\text{-}52)$$

where

Θ_j' = the angle measured in radians from north to the centerline of the j^{th} wind-direction sector

Θ' = the angle measured in radians from north to the point (r,Θ)

2.5.2 Area, Volume and Line Source Emissions

2.5.2.1 General

As explained in Section 2.4.2.1, the ISC Model area and volume sources are used to simulate the effects of emissions from a wide variety of industrial sources. Section 2.4.2.2 provides guidance on the use of the area source model and Section 2.4.2.3 provides guidance on the use of the volume source model. The volume source model is also used to simulate line sources. The following subsections give the area and volume source equations used by the long-term model.

2.5.2.2 The Long-Term Area Source Model

The seasonal average ground-level concentration at the point (r,Θ) with respect to the center of an area source is given by the expression

$$\chi_\ell\{r'>r_o,\Theta\} = \frac{2K\, x_o^2}{\sqrt{2\pi}\, R\, \Delta\Theta'} \left\{ \sum_{i,j,k} \left[\frac{Q_{A;i,k,\ell}\, f_{i,j,k,\ell}}{\bar{u}_{i,k}\{h\}\, \sigma_{z;k}}\, S\{\Theta\}\, V_{i,k,\ell} \right] \right. \qquad (2\text{-}53)$$

(Equation (2-53) continued on following page.)

(Equation (2-53) continued.)

$$\left.\left.\exp\left[-\psi\left(r'-r_o\right)/\bar{u}_{i,k}\{h\}\right]\right\}\right) \qquad (2\text{-}53)$$

where

R = radial distance from the lateral virtual point source to the receptor

$$= \left(\left(r'+x_y\right)^2 + y^2\right)^{1/2}$$

r' = distance from source center to receptor, measured along the plume axis

r_o = effective source radius = $x_o/\sqrt{\pi}$

y = lateral distance from the cloud axis to the receptor

x_y = lateral virtual distance (see Equation (2-48))

The Vertical Term $V_{i,k,\ell}$ for gaseous pollutants and small particulates is given by Equation (2-49) or Equation (2-50) with the emission height H defined by the user. If the user selects the gravitational settling and dry deposition option, the Vertical Term is given by Equation (2-51).

2.5.2.3 The Long-Term Volume Source Model

Equation (2-46) is also used to calculate seasonal average ground-level concentrations for volume sources. The user must assign initial lateral (σ_{yo}) and vertical (σ_{zo}) dimensions and the effective emission height H. A discussion of the application of the volume source model is given in Section 2.4.2.3.

2.5.3 The ISC Long-Term Dry Deposition Model

2.5.3.1 General

The concepts upon which the ISC long-term dry deposition model are based are discussed in Sections 2.4.1.2.c and 2.4.3.1.

2.5.3.2 Stack and Volume Source Emissions

The seasonal deposition at the point (r,Θ) with respect to the base of a stack or the center of a volume source for particulates in the n^{th} settling-velocity category or a gaseous pollutant with zero settling velocity V_{sn} and a reflection coefficient γ_n is given by

$$
\begin{aligned}
DEP_{\ell,n}\{r,\Theta\} = \frac{K\left(1-\gamma_n\right)\phi_n}{\sqrt{2\pi}\, r^2\, \Delta\Theta'} \sum_{i,j,k} \Bigg[& \frac{Q_{T;i,k,\ell}\, f_{i,j,k,\ell}}{\sigma_{z;k}} \\
& \exp\left[-\psi\, r/\bar{u}_{i,k}\{h\}\right] \; S\{\Theta\} \\
& \Bigg\{ \left[\bar{b}_k\, H_{i,k,\ell} + \left(1-\bar{b}_k\right) V_{sn} r/\bar{u}_{i,k}\{h\}\right] \qquad (2\text{-}54) \\
& \exp\left[-\frac{1}{2}\left(\frac{H_{i,k,\ell} - V_{sn} r/\bar{u}_{i,k}\{h\}}{\sigma_{z;k}}\right)^2\right] \\
& + \sum_{a=1}^{\infty} \Bigg[\gamma^{a-1} \Big[\bar{b}_k \left(2aH_{m;i,k,\ell} - H_{i,k,\ell}\right)
\end{aligned}
$$

(Equation (2-54) continued on following page.)

(Equation (2-54) continued.)

$$- \left(1 - \bar{b}_k\right) V_{sn} r/\bar{u}_{i,k}\{h\}\Big]$$

$$\exp\left[-\frac{1}{2}\left(\frac{2aH_{m;i,k,\ell} - H_{i,k,\ell} + V_{sn} r/\bar{u}_{i,k}\{h\}}{\sigma_{z;k}}\right)^2\right] \qquad (2\text{-}54)$$

$$+ \gamma^a \left[\bar{b}_k \left(2aH_{m;i,k,\ell} + H_{i,k,\ell}\right) + \left(1 - \bar{b}_k\right) V_{sn} r/\bar{u}_{i,k}\{h\}\right]$$

$$\exp\left[-\frac{1}{2}\left(\frac{2aH_{m;i,k,\ell} + H_{i,k,\ell} - V_{sn} r/\bar{u}_{i,k}\{h\}}{\sigma_{z;k}}\right)^2\right]\Bigg]\Bigg\}$$

where $Q_{\tau;i,k,\ell}$ is the product of the total time during the ℓ^{th} season and the seasonal emission rate $Q_{i,k,\ell}$ for the i^{th} wind-speed category and k^{th} stability category. For example, if the emission rate is in grams per second and there are 92 days in the summer season (June, July and August), $Q_{\tau;i,k,\ell=3}$ is given by $7.95 \times 10^6 \ Q_{i,k,\ell=3}$. It should be noted that the user need not vary the emission rate by season or by wind speed and stability. If an annual average emission rate is assumed, Q_τ is equal to 3.15×10^7 Q for a 365-day year. For convenience, 0^0 is defined as unity in Equation (2-54). For a plume comprised of N settling velocity categories, the total seasonal deposition is obtained by summing Equation (2-54) over the N settling-velocity categories. The program also sums the seasonal deposition values to obtain the annual deposition.

2.5.3.3 Area Source Emissions

With slight modifications, Equation (2-54) is applied to area source emissions. The user assigns the effective emission height H and the first line of Equation (2-54) is changed to

$$\mathrm{DEP}_{\ell,n}\{r,\Theta\} = \frac{K\left(1-\gamma_n\right)\phi_n x_o^2}{\sqrt{2\pi}\,R^2\,\Delta\Theta'}\sum_{i,j,k}\left[\frac{Q_{AT;i,k,\ell}\,f_{i,j,k,\ell}}{\sigma_{z;k}}\right.$$

$$\left.\exp\left[-\psi\,r/\bar{u}_{i,k}\{h\}\right]\;S\{\Theta\}\;.\;.\;.\right] \qquad (2\text{-}55)$$

where

$Q_{AT;i,k,\ell}$ = the product of the total time during the ℓ^{th} season and the emission rate per unit area for the i^{th} wind-speed category and k^{th} stability category

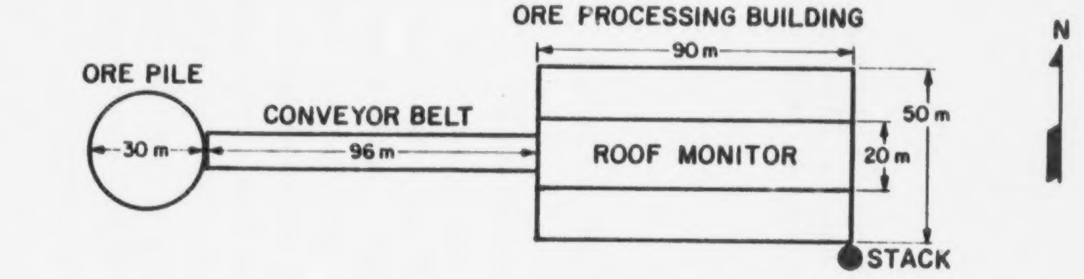
2.6 EXAMPLE PROBLEM

2.6.1 Description of a Hypothetical Potash Processing Plant

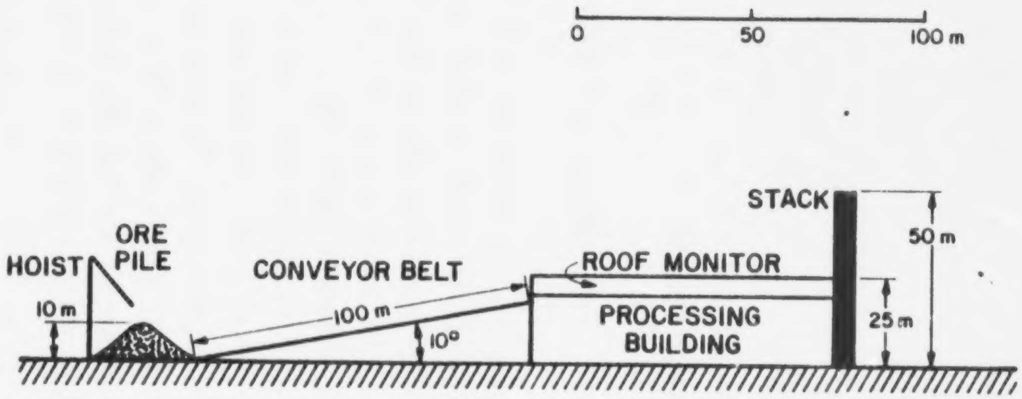
Figure 2-11(a) shows the plant layout and Figure 2-11(b) shows a side view of a hypothetical potash processing plant. Sylvinite ore is brought to the surface from an underground mine by a hoist and dumped on the ore storage pile. The ore then travels along an inclined conveyor belt to the ore processing building where the ore is crushed and screened. Fugitive particulate emissions resulting from the crushing and screening processes are discharged horizontally at ambient temperature from a roof monitor extending the length of the ore processing building. The ore is then refined by froth flotation and sent to the dryers. Particulate emissions produced by the drying process are discharged from a 50-meter stack, located adjacent to the ore processing building, which has a height of 25 meters.

2.6.2 Example ISCST Problem

Table 2-11 gives the emissions data for the hypothetical potash processing plant shown in Figure 2-11. The sylvinite mine and hoist are assumed to operate during the period 0800 to 1600 LST. Fugitive emissions


ORE PROCESSING BUILDING
90 m
ORE PILE
30 m
CONVEYOR BELT
96 m
ROOF MONITOR
20 m
50 m
STACK
N

(a) PLANT LAYOUT


0
50
100 m
STACK
50 m
HOIST
ORE PILE
10 m
CONVEYOR BELT
100 m
10°
ROOF MONITOR
PROCESSING BUILDING
25 m

(b) SIDE VIEW OF PLANT

FIGURE 2-11. Plant layout and side view of a hypothetical potash processing plant.

TABLE 2-11

EMISSIONS DATA FOR A HYPOTHETICAL POTASH PROCESSING PLANT

Source	Source			
	Ore Pile	Conveyor Belt	Roof Monitor	Main Stack
Particulate emission rate (g/sec)	353.4*	1.3	10.5	5
Emission height (m)	--	--	--	50
Exit velocity (m/sec)	--	--	--	8
Diameter (m)	--	--	--	1.0
Exit temperature (°K)	--	--	--	340

*Emission rate during the period 0800 to 1600 LST. The emission rate during the period 1600 to 0800 LST is 70.7 grams per second.

TABLE 2-12

PARTICLE-SIZE DISTRIBUTION, GRAVITATIONAL SETTLING VELOCITIES AND SURFACE REFLECTION COEFFICIENTS FOR PARTICULATE EMISSIONS FROM THE ORE PILE AND CONVEYOR BELT

Particle Size Category (μ)	Mass Mean Diameter (μ)	Mass Fraction ϕ_n	Settling Velocity V_{sn} (m/sec)	Reflection Coefficient γ_n
0 - 10	6.30	0.10	0.001	1.00
10 - 20	15.54	0.40	0.007	0.82
20 - 30	25.33	0.28	0.019	0.72
30 - 40	35.24	0.12	0.037	0.65
40 - 50	45.18	0.06	0.061	0.59
50 - 65	17.82	0.04	0.099	0.50

from the ore pile during the period 0800 to 1600 LST are higher than during the period 1600 to 0800 LST because the hoist is continuously dumping sylvinite ore onto the ore pile. A significant fraction of the fugitive emissions from the ore pile and the conveyor belt consists of large particulates. The particle-size distribution, gravitational settling velocities and surface reflection coefficients for particulate emissions from the ore pile and conveyor belt are given in Table 2-12. The settling velocities in Table 2-12 were calculated using Equations (2-41) and (2-42) with the particulate density assumed to be 1 gram per cubic centimeter; the reflection coefficients were obtained from Figure 2-8. The remainder of the particulate emissions from the hypothetical plant are assumed to be submicron particulates so that the effects of gravitational settling and dry deposition need not be included in the model calculations. The purpose of this example problem is to use ISCST to calculate 24-hour average particulate concentrations produced by emissions from the hypothetical potash plant. Additionally, estimates of the dry deposition of fugitive emissions from the ore pile and the conveyor belt are required for each 24-hour period.

The ore pile is modeled as an area source with the effective side x_o of the circular storage pile given by

$$x_o = \frac{\sqrt{\pi}}{2} D \qquad (2\text{-}56)$$

where D is the diameter of the base of the storage pile. The emission height H is set equal to the height of the ore pile (10 meters). The emission rate in grams per second is divided by the horizontal area of the storage pile (706.9 square meters) to obtain the area source emission rate in grams per second per square meter.

The conveyor belt is 10 meters wide and 100 meters long and is inclined at an angle of 10 degrees. Thus, the conveyor belt is modeled as ten 10-meter square volume sources. The initial lateral dimension of each source is obtained by dividing the width (10 meters) by 2.15. The initial vertical dimension σ_{zo} is arbitrarily set equal to 1 meter to account for the effects of local plant roughness elements. The emission height H_i for the i^{th} source is given by

$$H_i = L_i \sin \Theta \qquad (2\text{-}57)$$

where

H_i = the effective emission height for the i^{th} volume source

L_i = the length, measured from the beginning of the conveyor belt, to the center of the i^{th} volume source

Θ = the angle of inclination (10 degrees)

The volume source model is also used to model the 90-meter by 20-meter roof monitor. The roof monitor is approximated by four 20-meter square volume sources with the centers of the volume sources spaced at 23.3-meter intervals. The initial lateral dimension σ_{yo} of each of the four volume sources is obtained by dividing 23.3 meters by 2.15. Because the opening of the roof monitors extends from 20 to 25 meters above plant grade, the emission height H is set equal to 22.5 meters. In order to account for the effects of the aerodynamic wake of the processing building on the initial dispersion of emissions from the roof monitor, the initial vertical dimension σ_{zo} is obtained by dividing the building height (25 meters) by 2.15.

In summary, the effects of emissions from the hypothetical potash processing plant shown in Figure 2-11 can be simulated by 16 sources. A single area source represents the ore pile, ten volume sources simulate the inclined conveyor belt, four volume sources represent the roof monitor, and there is one stack. It should be noted that the stack height to building height ratio is less than 2.5 so that the ISC Model procedures for evaluating wake effects are applied to the stack emissions. The emissions data for the hypothetical plant given in Table 2-11 are converted to the form required for input to ISCST in Tables 2-13 and 2-14. The information given in Table 2-12 is also required for the ore pile and the conveyor belt. Because the plant is located in open terrain, all source elevations are set equal to zero. The X and Y coordinates assume that the origin of the coordinate system is located at the center of the ore pile. Source combinations that are of interest in analyzing the results of the calculations are as follows:

- Source 1 -- Ore Pile
- Sources 2-11 - Conveyor Belt
- Sources 12-12 -- Roof Monitor
- Source 16 -- Stack
- Sources 1-16 -- Plant as a Whole

Example ISCST runs that use the inputs given in Tables 2-12 through 2-14 and the receptor grid shown in Figure 2-3 to calculate concentrations and deposition are given in Appendix C. The hypothetical potash plant is assumed to be located in a rural area. Also, the plant does not contain large surface roughness elements or heat sources. Consequently, the Rural Mode is used in the ISCST calculations.

2.6.3 Example ISCLT Problem

The purpose of this example problem is to use ISCLT to calculate, for the receptor grid shown in Figure 2-3, annual average ground-level particulate concentrations produced by emissions from the hypothetical potash processing plant shown in Figure 2-11 as well as the annual deposition produced by fugitive emissions from the ore pile and conveyor belt. Annual

TABLE 2-13

EMISSIONS INVENTORY IN FORM FOR INPUT TO THE ISC DISPERSION MODEL

Source Number	Source Type*	X (m)	Y (m)	Z (m)	h (m)	V_s (m/sec) - Type 0 σ_{yo} (m) - Type 1 x_o (m) - Type 2	d (m) - Type 0 σ_{zo} (m) - Type 1	T_s (°K) Type 0	H_b (m) Type 0	Q (g/sec) - Types 0 & 1 g/(sec · m^2) - Type 2
1	2	-13.3	-13.3	0	10.0	26.6	--	--	--	5.00×10^{-1}
2	1	20	0	0	0.9	4.7	1.0	--	--	1.30×10^{-1}
3	1	30	0	0	2.6	4.7	1.0	--	--	1.30×10^{-1}
4	1	40	0	0	4.3	4.7	1.0	--	--	1.30×10^{-1}
5	1	49	0	0	6.1	4.7	1.0	--	--	1.30×10^{-1}
6	1	59	0	0	7.8	4.7	1.0	--	--	1.30×10^{-1}
7	1	69	0	0	9.6	4.7	1.0	--	--	1.30×10^{-1}
8	1	79	0	0	11.3	4.7	1.0	--	--	1.30×10^{-1}
9	1	89	0	0	13.0	4.7	1.0	--	--	1.30×10^{-1}
10	1	99	0	0	14.8	4.7	1.0	--	--	1.30×10^{-1}
11	1	109	0	0	16.5	4.7	1.0	--	--	1.30×10^{-1}
12	1	121	0	0	22.5	10.8	11.6	--	--	2.63
13	1	144	0	0	22.5	10.8	11.6	--	--	2.63
14	1	167	0	0	22.5	10.8	11.6	--	--	2.63
15	1	190	0	0	22.5	10.8	11.6	--	--	2.63
16**	0	201	30	0	50.0	8.0	1.0	340	25	5.00

*Source Type 0 = Stack, Source Type 1 = Volume and Source Type 2 = Area.

**Building width is 50 meters and building length is 90 meters (see Figure 2-11).

TABLE 2-14

PARTICULATE EMISSION RATES FOR THE ORE PILE

Hour (LST)	Emission Rate Q_A (g/(sec·m^2))	Total Hourly Emission Q_{AT}* (g/m^2)
0100	0.1	360
0200	0.1	360
0300	0.1	360
0400	0.1	360
0500	0.1	360
0600	0.1	360
0700	0.1	360
0800	0.5	1,800
0900	0.5	1,800
1000	0.5	1,800
1100	0.5	1,800
1200	0.5	1,800
1300	0.5	1,800
1400	0.5	1,800
1500	0.5	1,800
1600	0.1	360
1700	0.1	360
1800	0.1	360
1900	0.1	360
2000	0.1	360
2100	0.1	360
2200	0.1	360
2300	0.1	360
2400	0.1	360

*The amount of material emitted during each hour is required for the deposition calculations.

concentration and deposition estimates are also required for an air quality monitoring station located 2,108 meters from the center of the ore pile at a bearing of 014 degrees. With the exception of emissions from the ore pile and the conveyor belt, the emissions data for the plant are assumed to be identical to the data given in Tables 2-13 and 2-14. Fugitive emission rates for the ore pile and conveyor belt are given in Table 2-15 as functions of the wind-speed and Pasquill stability categories. The corresponding annual particulate emissions required for the annual deposition calculations are given in Table 2-16. Example ISCLT runs that calculate annual average concentration and total annual deposition values for this problem are presented in Appendix D.

TABLE 2-15

PARTICULATE EMISSION RATES FOR THE ORE PILE AND CONVEYOR BELT AS FUNCTIONS OF WIND SPEED AND STABILITY

Pasquill Stability Category	Emission Rate for Wind Speeds (m/sec) of					
	0-1.5	1.6-3.1	3.2-5.1	5.2-8.2	8.3-10.8	>10.8
(a) Ore Pile $Q_{A;i,k}$(g/(sec.m^2))						
A	0.40	0.50	--	--	--	--
B	0.30	0.40	0.50	--	--	--
C	0.20	0.30	0.40	0.50	0.70	1.00
D	0.10	0.25	0.50	0.50	0.70	1.00
E	--	0.20	0.25	--	--	--
F	0.05	0.10	--	--	--	--
(b) Individual Volume Sources $Q_{1,k}$(g/sec) Used to Represent the Conveyor Belt						
A	0.13	0.16	--	--	--	--
B	0.10	0.13	0.16	--	--	--
C	0.08	0.12	0.14	0.16	0.19	0.22
D	0.04	0.10	0.13	0.16	0.19	0.22
E	--	0.08	0.10	--	--	--
F	0.02	0.05	--	--	--	--

TABLE 2-16

ANNUAL PARTICULATE EMISSIONS FOR THE ORE PILE AND CONVEYOR BELT AS FUNCTIONS OF WIND SPEED AND STABILITY

Pasquill Stability Category	Annual Emissions for Wind Speeds (m/sec) of					
	0-1.5	1.6-3.1	3.2-5.1	5.2-8.2	8.3-10.8	>10.8
(a) Ore Pile $Q^*_{AT;i,k}$						
A	1.26×10^7	1.58×10^7	--	--	--	--
B	9.46×10^6	1.26×10^7	1.58×10^7	--	--	--
C	6.31×10^6	9.46×10^6	1.26×10^7	1.58×10^7	2.21×10^7	3.15×10^7
D	3.15×10^7	7.88×10^6	1.26×10^7	1.58×10^7	2.21×10^7	3.15×10^7
E	--	6.31×10^6	9.46×10^6	--	--	--
F	1.58×10^6	3.15×10^6	--	--	--	--
(b) Individual Volume Sources $Q^{**}_{T;i,k}$ (g) Used to Represent the Conveyor Belt						
A	4.10×10^6	5.05×10^6	--	--	--	--
B	3.15×10^6	4.10×10^6	5.05×10^6	--	--	--
C	2.52×10^6	3.78×10^6	4.42×10^2	5.05×10^6	5.99×10^6	6.94×10^6
D	1.26×10^6	3.15×10^6	4.10×10^6	5.05×10^6	5.99×10^6	6.94×10^6
E	--	2.52×10^6	3.15×10^6	--	--	--
F	6.31×10^5	1.58×10^6	--	--	--	--

*$Q_{AT;i,k}$ $(g/m^2) = Q_{A;i,k}(g/(sec \cdot m^2)) \times (3600\ sec/hr) \times (24\ hr/day) \times (365\ day/yr) = 3,1536 \times 10^7\ Q_{A;i,k}$

**Similarly, $Q_{T;i,k}(g) = 3.1536 \times 10^7\ Q_{i,k}\ (g/sec)$

SECTION 3

USER'S INSTRUCTIONS FOR THE ISC SHORT-TERM (ISCST) MODEL PROGRAM

3.1 SUMMARY OF PROGRAM OPTIONS, DATA REQUIREMENTS AND OUTPUT

3.1.1 Summary of ISCST Program Options

The program options of the ISC Dispersion Model short-term computer program (ISCST) consist of three general categories:

- Meteorological data input options
- Dispersion model options
- Output options

Each category is discussed separately below.

a. Meteorological Data Input Options. Table 3-1 lists the meteorological data input options for the ISCST computer program. Hourly meteorological data may be input by card deck or by means of the preprocessed meteorological data tape (see Appendix G). If available, site-specific wind-profile exponents and vertical potential temperature gradients may be input for each stability category or for each combination of wind-speed and stability categories. The Rural Mode, Urban Mode 1 or Urban Mode 2 (see Section 2.2.1.1) may be selected by the user. Source-specific entrainment coefficients may also be used in the plume-rise calculations (see Section 2.3). Also, the user may direct the program to calculate plume rise as a function of downwind distance or to assume that the final plume rise applies at all downwind distances. If the wind system measurement height differs from 10 meters, the actual measurement height should be entered.

TABLE 3-1

METEOROLOGICAL DATA INPUT OPTIONS FOR ISCST

Input of hourly data by preprocessed data tape or card deck
Site-specific wind-profile exponents
Site-specific vertical potential temperature gradients
Rural Mode or Urban Mode 1 or 2
Entrainment coefficients other than the Briggs (1975) coefficients
Final or distance dependent plume rise
Wind system measurement height other than 10 meters

TABLE 3-2

DISPERSION-MODEL OPTIONS FOR ISCST

Concentration or dry deposition calculations
Inclusion of effects of gravitational settling and/or dry deposition in concentration calculations
Inclusion of terrain effects (concentration calculations only)
Cartesian or polar receptor system
Discrete receptors (Cartesian or polar system)
Stack, volume and area sources
Pollutant emission rates held constant or varied by hour of the day, by season or month, by hour of the day and season, or by wind speed and stability
Time-dependent exponential decay of pollutants
Inclusion of building wake and stack-tip downwash effects
Time periods for which concentration or deposition calculations are to be made (1, 2, 3, 4, 6, 8, 12 and 24 hours and N days are possible, where N is the total number of days considered)
Specific days and/or time periods within a day for which concentration or deposition calculations are to be made

b. Dispersion Model Options. Table 3-2 lists the dispersion model options for the ISCST computer program. The user may elect to make either concentration or dry deposition calculations. In the case of concentration calculations, the effects of gravitational settling and/or dry deposition may be included in the calculations for areas of open terrain. Terrain effects may be included in the model calculations if the maximum terrain elevation does not exceed the minimum stack top elevation. In general, the gravitational settling and dry deposition options should not be used in complex terrain (see Sections 2.4.1.2.c and 2.4.3). The user may select either a Cartesian or a polar receptor system and may also input discrete receptor points with either system. ISCST calculates concentration or deposition values for stack, volume and area source emissions. The volume source option is also used to simulate line sources (see Section 2.4.2.3). Pollutant emission rates may be held constant or varied by hour of the day, by season or month, by hour of the day and season, or by wind speed and stability. The effects of time-dependent exponential decay of a pollutant as a result of chemical transformation or other removal processes may also be included in the model calculations (see Section 2.4.1). If a stack is located on or adjacent to a building, the user must input the building dimensions (length, width and height) in order for the program to consider the effects of the building's aerodynamic wake on plume dispersion. The user must select the time periods over which concentration is to be averaged or deposition is to be summed. The user must also select the specific days and/or time periods within specific days for which concentration or deposition calculations are to be made. For example, the user may wish to calculate 3-hour average concentrations for the third 3-hour period on Day 118.

c. Output Options. Table 3-3 lists the ISCST program output options. A more detailed discussion of the ISCST output information is given in Section 3.1.3.

TABLE 3-3

ISCST OUTPUT OPTIONS

Results of the calculations stored on magnetic tape

Printout of program control parameters, source data and receptor data

Printout of tables of hourly meteorological data for each specified day

Printout of "N"-day average concentration or total deposition calculated at each receptor for any desired combinations of sources

Printout of the concentration or deposition values calculated for any desired combinations of sources at all receptors for any specified day or time period within the day

Printout of tables of highest and second-highest concentration or deposition values calculated at each receptor for each specified time period during an "N"-day period for any desired combinations of sources

Printout of tables of the maximum 50 concentration or deposition values calculated for any desired combinations of sources for each specified time period

The results of all ISCST calculations may be stored on magnetic tape. The user may also elect to print one or more of the following tables:

- The program control parameters, source data and receptor data
- Hourly meteorological inputs for each specified day
- The "N"-day average concentration or "N"-day total deposition calculated at each receptor for any desired combinations of sources
- The concentration or deposition values calculated for any desired combinations of sources at all receptors for any specified day or time period within a day
- The highest and second-highest concentration or deposition values calculated for any desired combinations of sources at each receptor for each specified averaging time (concentration) or summation time (deposition) during an "N"-day period
- The maximum 50 concentration or deposition values calculated for any desired combinations of sources for each specified averaging time (concentration) or summation time (deposition)

It should be noted that a given problem run may generate a large print output (see Section 3.2.5.b). Consequently, it may be more convenient to make multiple program runs for a given problem.

3.1.2 Data Input Requirements

This section provides a description of all input data parameters required by the ISCST program. The user should note that some input parameters are not read or are ignored by the program, depending on what values control parameters have been assigned by the user. Except where noted, all data are read from card images.

a. Program Control Parameter Data. These data contain parameters which provide user-control of all program options.

Parameter Name	
ISW(1)	Concentration/Deposition Option -- Directs the program to calculate either average concentration or total deposition. A value of "1" indicates average concentration and a "2" indicates total deposition. The default value equals "1".
ISW(2)	Receptor Grid System Option -- Specifies whether a right-handed rectangular Cartesian coordinate system or a polar coordinate system is used to reference the receptor grid. A value of "1" indicates the Cartesian coordinate system, and "2" indicates the polar coordinate system. Additionally, a "3" or "4" value will automatically generate a grid system using the Cartesian or polar coordinate systems, respectively, with user-defined starting locations and spacing distances. The default value equals "1".
ISW(3)	Discrete Receptor Option - Specifies whether a right-handed rectangular Cartesian coordinate system or a polar coordinate system is used to reference discrete receptor

Parameter Name	
ISW(3) (Cont.)	points. A value of "1" indicates the Cartesian coordinate system and a "2" indicates the polar coordinate system. The default value equals "1".
ISW(4)	Receptor Terrain Elevation Option -- Allows the user to input terrain elevations for all receptor points. A value of "1" directs the program to read user-provided terrain elevations. Receptor elevations below stack base elevation are set equal to stack base elevation. A value of "0" assumes level terrain and no terrain elevations are read by the program. The default value equals "0".
ISW(5)	Output Tape Option -- Allows all calculated average concentration or total deposition values to be written onto a magnetic tape. A value of "1" writes calculated values to an output tape. Refer to Section 3.2.4.b for a complete description of the output produced from the use of this option. A "0" value does not write any calculations to an output tape. The default value equals "0".
ISW(6)	Print Input Data Option -- Allows the user to print all input data parameters. A value of "0" indicates no input data are listed. A "1" indicates that all program control parameters and model constants, receptor site data and source data are printed. A "2" value is the same as the "1" option except that all hourly meteorological data used in the calculations are also printed.
ISW(7)- ISW(14)	Time Period Options -- These options allow the user to compute average concentration or total deposition based on up to eight time periods. Parameters ISW(7) through ISW(14) respectively correspond to 1-, 2-, 3-, 4-, 6-,

Parameter Name	
ISW(7)- ISW(14)	8-, 12- and 24-hour time periods. The user may choose any number of the eight time periods. A value of "1" for any of the eight parameters directs the program to compute average concentration or total deposition values for the corresponding time period. A "0" value for any of the eight time-period parameters directs the program not to make calculations for the corresponding time period. The default values equal "0".
ISW(15)*	Output "N"-Day Table Option -- Allows the user to print average concentration or total deposition for the total number of days of meteorological data processed by the problem run for source group combinations chosen by the user. A value of "1" employs this option; "N"-day tables are not printed if ISW(15) has a "0" value. The default value equals "0".
ISW(16)*	Output Daily Tables Option -- Allows the user to print average concentration or total deposition values for all time periods and source groups specified by the user for each day of meteorological data processed. A value of "1" directs the program to print these tables; these tables are not printed if ISW(16) has a "0" value or if parameters ISW(7) through ISW(14) equal "0". The default value equals "0".
ISW(17)*	Output Highest and Second Highest Tables Option -- Allows the user to print the highest and second highest average concentration or total deposition calculated at each recep-

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*The four parameters ISW(15) through ISW(18) pertain to output table options. Refer to Section 3.1.3 for a more complete summary of the contents of each type of output table.

Parameter Name	
ISW(17)* (Cont.)	tor. A set of the highest and second highest tables is printed for each time period and source group combination chosen by the user. A value of "1" directs the program to print these tables; these tables are not printed if ISW(17) has a "0" value or if parameters ISW(7) through ISW(14) equal "0". The default value equals "0".
ISW(18)*	Output Maximum 50 Tables Option -- Specifies whether or not tables of the 50 highest calculated average concentration or total deposition values are printed for each time period and source group specified by the user. A "1" value employs this option; these tables are not printed if ISW(18) has a "0" value or if parameters ISW(7) through ISW(14) equal "0". The default value equals "0".
ISW(19)	Meteorological Data Option -- A "1" value directs the program to read hourly meteorological data from FORTRAN logical unit IMET in a format compatible with that generated by the preprocessor program (see Appendix G). A "2" value directs the program to read hourly meteorological data in a card image format. The default value equals "1".
ISW(20)	Rural/Urban Option -- Specifies whether rural or urban surface mixing heights are read from the hourly meteorological data. Also, this parameter option provides two urban modes of adjustment of input stability categories (see Table 2-3). A value of "0" directs the pro-

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*The four parameters ISW(15) through ISW(18) pertain to output table options. Refer to Section 3.1.3 for a more complete summary of the contents of each type of output table.

Parameter Name	
ISW(20) (Cont.)	gram to read rural mixing heights. A "1" value causes the program to read urban mixing heights with Urban Mode 1 adjustments to the input stability categories. A "2" value causes the program to read urban mixing heights with Urban Mode 2 adjustments to the input stability categories. The default value equals "0". It should be noted that if Meteorological Data Option (ISW(19)) has a value of "2", the program automatically assigns a "0" value to ISW(20) and ignores any conflicting value entered by the user.
ISW(21) (Cont.)	Wind Profile Exponent Option -- This option allows the user to enter wind profile exponent values or allows the program to provide default wind profile exponent values. If a value of "1" is entered, the program provides default values. See Table 2-2 for the default values used by the program. If a value of "2" is entered, the program reads user-provided wind profile exponents in input parameter PDEF. These values remain constant throughout the problem run. If a value of "3" is entered, the program reads user-provided wind profile exponent values in input parameter P for each hour of meteorological data processed by the program. Note that the ISW(21) equals "3" option assumes the hourly meteorological data are in a card image format (ISW(19) = "2"). The default value of ISW(21) equals "1".
ISW(22)	Vertical Potential Temperature Gradient Option -- This option allows the user to enter vertical potential temperature gradient values or allows the program to provide default vertical potential temperature gradient values. If a value of "1" is entered, the program provides default

Parameter Name	
ISW(22) (Cont.)	values. See Table 2-2 for the default values used by the program. If a value of "2" is entered, the program reads user-provided vertical potential temperature gradient values in input parameter DTHDEF. These values remain constant throughout the problem run. If a value of "3" is entered, the program reads user-provided vertical potential temperature gradient values in input parameter DTHDZ for each hour of meteorological data processed by the program. Note that the ISW(22) equals "3" option assumes hourly meteorological data are in a card image format (ISW(19) equals "2"). The default value of ISW(22) equals "1".
ISW(23)	Variable Source Emission Rate Option -- Allows the user to specify scalars which are multiplied by the sources' average emission rates. This parameter is employed by the user when it is desired to vary the average emission rates for all sources. It is also possible to vary the emission rates for individual sources with the QFLG parameter option. These scalars may vary as a function of season, month, hour of the day, hour of the day and season, or wind speed and stability category. A value of "1" allows the user to enter four seasonal scalars; a "2" allows the user to enter twelve monthly scalars; a "3" allows the user to enter twenty-four scalars for each hour of the day; a "4" value allows the user to enter thirty-six scalars for six wind speed categories for each of the six stability categories; a "5" value allows the user to enter ninty-six scalars for twenty-four hourly values for each of the four seasons. A "0" value directs

Parameter Name	Parameter
	the program not to vary average emission rates for all sources, and allows the use of the QFLG parameter option for the individual sources. The default value of this parameter equals "0".
ISW(24)	Plume Rise Option -- Allows the program to consider only the final plume rise at all downwind receptor locations if a value of "1" is entered. If a value of "2" is entered, the program computes plume rise as a function of the downwind distance of each receptor. The default value of ISW(24) equals "1".
ISW(25)	Stack-Tip Downwash Option -- Allows the program to use the physical stack height entered by the user or to modify the physical stack height of all stack-type sources entered in order to account for stack-tip downwash effects (Briggs, 1973). If a value of "1" is entered, all physsical stack heights entered by the user are used throughout the problem run; if a value of "2" is entered, all physical stack heights entered are modified to account for stack-tip downwash. The default value of ISW(25) equals "1".
NSOURC	Number of Sources -- This parameter specifies the total number of sources to be processed by the problem run.
NXPNTS	X-Axis/Range Receptor Grid Size -- This parameter specifies the number of east-west receptor grid locations for the Cartesian coordinate system X-axis, or the number of receptor grid ranges (rings) in the polar coordinate system (depending on which receptor grid system is chosen by

Parameter Name	
NXPNTS (Cont.)	the user with parameter ISW(2)). A "0" value causes the program to assume that no regular (non-discrete) receptor grid is used.
NYPNTS	Y-Axis/Radial Receptor Grid Size -- This parameter specifies the number of north-south receptor grid locations for the Cartesian coordinate system Y-axis, or the number of receptor grid direction radials in the polar grid system (depending on which receptor grid system is chosen by the user with parameter ISW(2)). A "0" value causes the program to assume that no regular (non-discrete) receptor grid is used.
NXWYPT	Number of Discrete Receptors -- This parameter indicates the total number of discrete receptors to be processed by the problem run. A "0" value causes the program to assume that no discrete receptors are used.
NGROUP	Number of Source Groups -- This parameter specifies the number of source groups desired. Each source group consists of any desired combination of sources. A "0" value defines one source group which consists of all sources. The default value equals "0". A maximum of 150 source groups are allowed.
IPERD	Single Time Period Interval Option -- This parameter allows the user to specify one time period interval out of all possible time period intervals within a day. The use of this option directs the program to print only one time period interval specified for daily output tables (see Section 3.1.3.b). For example, if the user desires to print only

Parameter Name	
IPERD (Cont.)	the fifth 3-hour time period, IPERD requires a value of "5". Also, parameter ISW(9) must equal "1" in order to compute average concentration or total deposition based on a 3-hour time period. A "0" value directs the program to consider all intervals of a given time period.
NHOURS	Number of Hours Per Day of Hourly Meteorological Data -- This parameter is used only when hourly meteorological data are read from card images (parameter ISW(19) equals "2"). This parameter specifies the number of hours per day of meteorological data. For example, one need not enter 24 hours of meteorological data in order to calculate a 3-hour average concentration from only 3 hours of meteorological data.
NDAYS	Number of Days of Meteorological Data -- This parameter is used only when hourly meteorological data are read from card images (parameter ISW(19) equals "2"). This parameter specifies the total number of days of meteorological data to be processed by the program. The default value assumes one day (a value equal to "1") of meteorological data.
NSOGRP	Number of Sources Defining Source Groups -- This parameter is not read if the parameter NGROUP has a "0" value. This parameter is an array (NGROUP long) which indicates how many source identification numbers are read by the program in order to define each source group. The source identification numbers themselves are read in parameter IDSOR. Refer to parameter IDSOR for an example of the use of the parameter NSOGRP in association with parameter IDSOR. A maximum of 150 source groups may be used.

Parameter Name	
IDSOR	Source Identification Numbers Defining Source Groups -- This parameter is not read if parameter NGROUP has a "0" value. This parameter is an array which contains the source identification numbers and/or the lower and upper bounds of source identification numbers to be summed over, which are used to define a source group. This parameter is used in association with parameter NSOGRP discussed above. The following should illustrate the interactive use of parameters NGROUP, NSOGRP and IDSOR. Let us assume that we have 50 sources whose identification numbers are 10, 20, 30, . . ., 490, 500. First, if one desires only to see the average concentration or total deposition calculated from all sources, the parameter NGROUP should equal "0". The parameters NSOGRP and IDSOR are not required by the program and are not input by the user. Next, let us assume that one desires to see the average concentration or total deposition contribution individually of sources with identification numbers 10, 100, 200, 300, 400 and 500 as well as the combined contributions of sources with numbers 10 through 100, 50 through 260, 100 through 200 plus 400 through 500, and of all sources combined (10 through 500). Hence, the average concentration or total deposition contributions from six individual sources are desired plus the contributions from each of four sets of combined sources for a total of ten source groups. Thus, a value of "10" must be entered for parameter NGROUP. For parameter NSOGRP, one enters the ten values: 1, 1, 1, 1, 1, 1, 2, 2, 4 and 2. For parameter IDSOR, one enters the source identification numbers: 10, 100, 200, 300, 400, 500, 10, -100, 50, -260, 100, -200, 400, -500, 10 and -500. Now let us examine the relationship between those values entered in parameters NSOGRP and IDSOR. The first six entries of both NSOGRP

Parameter Name

IDSOR (Cont.)

and IDSOR are in a one-to-one correspondence; the "1" value entered in parameter NSOGRP implies that only one source identification number is read by the program in the IDSOR array in order to define a complete source group. The seventh entry in parameter NSOGRP (a "2") indicates that the source identification numbers 10 and -100 (the seventh and eighth entries in IDSOR) define a source group. The minus sign preceding source identification number "100" indicates to the program to inclusively sum over all sources with identification numbers ranging from "10" to "100". The user need not be concerned by the fact that no source number of, say, "43" exists. The program only sums over those source numbers defined (in this case, 10, 20, 30, . . ., 90, 100). The eighth entry in parameter NSOGRP (a "2") specifies a source group including source numbers "50" through "260" which are the next set of values in parameter IDSOR. If one desires to see source contributions from consecutive source numbers, and also desires to exclude some source numbers, the next entry in parameter NSOGRP (a "4") illustrates this procedure. The value "4" implies that four source numbers are read by the program in order to define a source group. The four source identification numbers read by the program in parameter IDSOR, which are the source numbers following the last source numbers used to define the preceding source group, are 100, -200, 400, -500. This arrangement implies that inclusive summing over all sources from "100" to "200" and "400" to "500" is desired, excluding source numbers "210" to "390". Finally, it is still possible to obtain the combined contribution from all sources as shown in the last source group. In summary, we have: (1) Parameter NGROUP is a value which represents the number of source groups

Parameter Name	
IDSOR (Cont.)	desired; (2) The values in parameter NSOGRP indicate the number of source identification numbers read by the program in parameter IDSOR; and, (3) parameter IDSOR contains the source identification numbers used to define a source group, where a minus sign preceding a source number implies inclusive summing from the previous source number entered to the source number with the minus sign. The number of source identification numbers cannot exceed two hundred values for parameter IDSOR.

b. Meteorological-Related Constants. These data consist of parameters related to the meteorological conditions of the problem run. They are constants which are initialized at the beginning of the problem run and remain constant throughout the problem run (as opposed to the hourly meteorological data which change throughout the problem run).

Parameter Name	
PDEF	Wind Profile Exponents -- These data are read by the program only if option ISW(21) has a value equal to "2". This parameter is an array containing wind profile exponents for six stability categories, where each stability category contains six values for the six wind speed categories. A total of thirty-six wind profile exponents are entered by the user.
DTHDEF	Vertical Potential Temperature Gradients -- These data are read by the program only if option ISW(22) has a value equal to "2". This parameter is an array containing vertical potential temperature gradients (degrees Kelvin/meter) for six stability categories, where each stability category con-

Parameter Name	
DTHDEF (Cont.)	tains six values for the six wind speed categories. A total of thirty-six vertical potential temperature gradients are entered by the user.
UCATS	Wind Speed Categories -- This parameter contains five values which specify the upper bound of the first through fifth wind speed categories (meters/second). The program assumes no upper limit on the sixth wind speed category. The default values equal 1.54, 3.09, 5.14, 8.23 and 10.8 meters per second for the first through fifth categories, respectively.
BETA1	Adiabatic Entrainment Coefficient -- This parameter is used by the plume rise section of the model as the entrainment coefficient for adiabatic conditions (vertical potential temperature gradients less than or equal to zero). The default value equals 0.6 (Briggs, 1975).
BETA2	Stable Entrainment Coefficient -- This parameter is used by the plume rise section of the model as the entrainment coefficient for stable conditions (vertical potential temperature gradients greater than zero). The default value equals 0.6 (Briggs, 1975).
ZR	Wind Speed Reference Height -- This parameter specifies the height (meters) at which the wind speed was measured. The default value equals 10.0 meters.
DECAY*	Decay Coefficient -- This parameter is the decay coefficient (seconds^{-1}) used to describe decay of a pollutant due to

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*This parameter is read by the program only if the hourly meteorological data are in a preprocessed format (parameter ISW(19) equals "1").

Parameter Name	
DECAY*	chemical depletion. The default value equals "0" for no decay.
IDAY*	Meteorological Julian Day Indicator -- This parameter consists of an array of 366 entries, where each entry indicates whether or not a meteorological day of data is processed by the program. The entry number of the array corresponds to the Julian Day of meteorological data. For example, the 140th entry IDAY(140) corresponds to Julian Day 140. An entry with a "1" value directs the program to process the corresponding day of meteorological data. A "0" value directs the program to ignore that corresponding day. The default assumes "0" values for all 366 entries.
ISS*	Surface Station Number -- This parameter specifies the surface station number of the meteorological data being used. The surface station number usually corresponds to the WBAN station identification number for a given observation station. The number is usually a five-digit integer.
ISY*	Year of Surface Station Data -- This parameter specifies the year of the surface station meteorological data. Only the last two digits of the year are entered.
IUS*	Upper Air Station Number -- This parameter specifies the upper air station number of the meteorological data being used. The upper air station number usually corresponds to

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*This parameter is read by the program only if the hourly meteorological data are in a preprocessed format (parameter ISW(19) equals "1").

Parameter Name	
IUS* (Cont.)	the WBAN station identification number for a given observation station. The number is usually a five-digit number.
IUY*	Year of Upper Air Station Data -- This parameter specifies the year of the upper air station meteorological data. Only the last two digits of the year are entered.

c. Identification Labels and Model Constants. These data consist of parameters pertaining to heading and identification labels and program constants.

Parameter Name	
TITLE	Heading Label -- This parameter allows the user to enter up to 60 characters in order to identify a problem run. The information entered in this parameter appears at the top of each page of print output.
IQUN	Source Emission Rate Label -- This parameter provides the user with up to 12 characters in order to identify the emission rate units of all sources. The default label is (GRAMS/SEC) when calculating average concentration and (GRAMS) when calculating total deposition. All area source emission rate labels automatically include units of per square meter.
ICHIUN	Output Units Label -- This parameter provides the user with a 28-character label in order to identify the units of aver-

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*This parameter is read by the program only if the hourly meteorological data are in a preprocessed format (parameter ISW(19) equals "1").

Parameter Name	
ICHIUN (Cont.)	age concentration or total deposition. The default value is (MICROGRAMS/CUBIC METER) for average concentration calculations and (GRAMS/SQUARE METER) for total deposition calculations.
TK	Source Emission Rate Conversion Factor -- This parameter allows the user to scale the source emission rate for all sources in order to convert the emission rate units. This parameter is used in conjunction with label parameters IQUN and ICHIUN. The default value equals 1.0×10^6 for average concentration calculations and 1.0 for total deposition calculations.
IMET	FORTRAN Logical Unit Number for Hourly Meteorological Data -- This parameter specifies the FORTRAN logical unit number of the device from which the hourly meteorological data are read. The default value equals "9" for hourly meteorological data which are in a preprocessed format. The default value for card image meteorological data is the same as the logical unit number for all card input data.
ITAP	FORTRAN Logical Unit Number of Output Tape -- This parameter is ignored by the program if no output tape is generated by the problem run (ISW(5) equals "0"). This parameter specifies the FORTRAN logical unit number of the output device with which the output tape is externally associated. The default value equals "3".

d. Receptor Data. These data consist of the (X, Y) or (range, theta) locations of all receptor points. Also included are the receptor terrain elevations.

Parameter Name	
GRIDX	Receptor Grid X-Axis or Range Data -- This parameter is read by the program only if input parameters NXPNTS and NYPNTS are both greater than zero. This parameter is an array which has different functions depending on the value of ISW(2). If ISW(2) equals "1", this parameter contains NXPNTS values of the X-axis receptor grid points (meters). If ISW(2) equals "2" or "4", this parameter contains NXPNTS values of the receptor grid ranges (rings) in meters. If ISW(2) equals "3", the first entry of this parameter contains the starting location (meters) of the X-axis receptor grid and the second entry contains the incremental value (meters) with which the remaining NXPNTS values of the X-axis are generated.
GRIDY	Receptor Grid Y-Axis or Direction Radial Data -- This parameter is read by the program only if input parameters NXPNTS and NYPNTS are both greater than zero. This parameter is an array which has different functions depending on the value of ISW(2). If ISW(2) equals "1", this parameter contains NYPNTS values of the Y-axis receptor grid points (meters). If ISW(2) equals "2", this parameter contains NYPNTS values of the direction radials (degrees) for the receptor grid. The program requires that these values not be fractional values but integer values within the range of 1 to 360 degrees. The default value equals "360" degrees. If ISW(2) equals "3", the first entry of this parameter contains the starting location (meters) of the Y-axis receptor grid and the second entry contains the incremental value (meters) with which the remaining NYPNTS values of the Y-axis are generated. If ISW(2) equals "4", the first entry of this parameter contains the starting direction radial location (degrees)

Parameter Name	
GRIDY (Cont.)	of the receptor grid and the second entry contains the incremental value (degrees) with which the remaining NYPNTS direction radial values of the receptor grid are generated. All values generated must be integers within the range of 1 to 360 degrees. The default value equals "360" degrees.
XDIS	Discrete Receptor X or Range Data -- This parameter is read by the program only if parameter NXWYPT is greater than zero. This parameter is an array which has different functions depending on the value of parameter ISW(3). If ISW(3) equals "1", this parameter contains NXWYPT discrete receptor X locations (meters). If ISW(3) equals "2", this parameter contains NXWYPT discrete receptor range locations (meters). The values entered in this parameter are used in association with those in parameter YDIS.
YDIS	Discrete Receptor Y or Direction Data -- This parameter is read by the program only if NXWYPT is greater than zero. This parameter is an array which has different functions depending on the value of parameter ISW(3). If ISW(3) equals "1", this parameter contains NXWYPT discrete receptor Y locations (meters). If ISW(3) equals "2", this parameter contains NXWYPT discrete receptor direction values (degrees). These direction values must not be fractional in value, but integer values within the range of 1 to 360 degrees where the default value is "360" degrees. The values entered in this parameter are used in association with those in parameter XDIS.
GRIDZ	Receptor Terrain Elevation Data -- This parameter is read only if parameter ISW(4) equals "1". This parameter is an

Parameter Name	
GRIDZ (Cont.)	array which contains all the receptor terrain elevations (feet)[*] for the receptor grid and discrete receptors. The terrain elevations for the receptor grid are entered first (if there is a receptor grid). Receptor elevation Z_{ij} corresponds to the i^{th} X coordinate (range) and j^{th} Y coordinate (direction radial). Begin with Z_{11} and enter NXPNTS values (Z_{11}, Z_{21}, Z_{31}, ...). Then, starting with a new card image, enter NXPNTS values (Z_{12}, Z_{22}, Z_{32}, ...). Continue until all regular receptor elevations have been entered. The terrain elevations for the discrete receptors (if any) are entered next. Beginning with a new card image, enter the terrain elevations for the discrete receptor points in the order the discrete receptor locations were entered into parameters XDIS and YDIS.

e. Source Data. These data consist of all necessary information required for each source entered by the user. Because the program can process three types of sources (stack, volume and area), some source types require more information than other types. The following input parameters are required by all source types.

Parameter Name	
NSO	Source Identification Number -- This parameter is a number which uniquely identifies each source. The program uses this identification number for any output tables that are generated requiring individual source identification. This number must be a positive number.

---

[*] Ground elevations in feet are required for this otherwise metric program to afford compatibility with the units used in the routinely available U.S.G.S. topographic maps.

Parameter Name	
ITYPE	Source Type Indicator -- This parameter specifies the type of source. If a value of "0" is entered, this is a stack-type source. Similarly, a "1" is entered for a volume-type source. A "2" is entered for an area-type source. Consult Sections 2.4.1 and 2.4.2 for a technical discussion of these source types.
NVS	Number of Gravitational Settling Categories -- This parameter specifies the number of gravitational settling categories to be considered. This parameter is used for sources with particulates or droplets with significant gravitational settling velocities. A maximum of 20 categories is allowed for each source.
QFLG	Variational Source Emission Rate Option -- This parameter is ignored by the program if ISW(23) has a non-zero value. This parameter allows the user to specify scalars which are multiplied by this individual source's average emission rate. These scalars may vary as a function of season, month, hour of the day, season and hour of the day, or stability category and wind speed. The implementation of this parameter is the same as that of parameter ISW(23). Refer to the description of parameter ISW(23) for an explanation of what values are associated with each variational function.
Q	Emission Rate -- This parameter specifies the average emission rate of the source. If average concentration is calculated, the units for stack and volume sources are mass per time and for area sources are mass per square meter per time. If total deposition is calculated, the units

Parameter Name	
Q (Cont.)	for stack and volume sources are mass and for area sources are mass per square meter.
XS	X Location -- This parameter specifies the relative X location (meters) of the center of a stack or volume source and of the southwest corner of an area source.
YS	Y Location -- This parameter specifies the relative Y location (meters) of the center of a stack or volume source and of the southwest corner of an area source.
ZS	Source Elevation -- This parameter specifies the elevation (meters above mean sea level) of the source at the source base.
Stack-Source Parameters	
WAKE	Wake Effects Option -- This parameter pertains only to stacks with building wake effects (parameters HB, HL and HW greater than zero). Enter a "0" value to calculate an "upper bound" average concentration or total deposition. Enter a "1" value to calculate a "lower bound" average concentration or total deposition. The appropriate value for this parameter depends on building shape and stack placement with respect to the building. Consult Section 2.4.1.1.d for a technical discussion of building wake effects. The default value equals "0".
HS	Stack Height -- This parameter specifies the height of the stack above the ground (meters).
TS	Stack Exit Temperature -- This parameter specifies the stack exit temperature in degrees Kelvin. If this value is less

Stack-Source Parameters	
TS (Cont.)	than the ambient air temperature for a given hour, the program sets this parameter equal to the ambient air temperature.
VS	Stack Exit Velocity -- This parameter specifies the stack exit velocity in meters per second.
D	Stack Diameter -- This parameter specifies the inner stack diameter in meters.
HB*	Building Height -- This parameter specifies the height of a building adjacent to this stack (meters).
HL*	Building Length -- This parameter specifies the length of a building adjacent to this stack (meters).
HW*	Building Width -- This parameter specifies the width of a building adjacent to this stack (meters).

Volume-Source Parameters	
H	Center Height -- This parameter specifies the height of the center of the volume source above the ground (meters).
SIGZO	Initial Vertical Dimension -- This parameter specifies the initial vertical dimension σ_{zo} of the volume source (meters).

---

*If non-zero values are entered for parameters HB or HL and HW, the program automatically uses the building wake effects option (see Section 2.4.1.1.d). However, if HB, HL, and HW are not punched, or are equal to "0," wake effects for the respective source are not considered.

Volume-Source Parameters

SIGYO	Initial Horizontal Dimension -- This parameter specifies the initial horizontal dimension σ_{yo} of the volume source (meters).

Area-Source Parameters

H	Effective Emission Height -- This parameter specifies the effective emission height of the area source (meters).
XO	Area Source Width -- This parameter specifies the width x_o of the square area source (meters).

Gravitational Settling Categories Parameters

PHI	Mass Fraction -- This parameter is an array which specifies the mass fraction of particulates for each settling velocity category. A maximum of 20 values per source may be entered.
VSN	Settling Velocity -- This parameter is an array which specifies the gravitational settling velocity (meters/second) for each settling velocity category. A maximum of 20 values per source may be entered.
GAMMA	Surface Reflection Coefficient -- This parameter is an array which contains the surface reflection coefficient for each settling velocity category. A maximum of 20 values per source may be entered.

Parameter Name	
QTK	Source Emission Rate Scalars -- This parameter is applicable only to sources whose emission rates are multiplied by variational scalar values. If parameter ISW(23) is greater than zero, this parameter applies to all sources in the problem run. If parameter ISW(23) equals zero, this parameter is read by the program for each source for which the parameter QFLG is greater than zero. If both parameters ISW(23) and QFLG equal zero for all sources, this parameter is not read by the program. This parameter is an array which contains the source emission rate scalars used to multiply the average emission rate of a (all) source(s). The format in which the scalar values are entered depends on the value of either parameter QFLG or ISW(23) (whichever parameter is applicable). If this value equals "1", enter four seasonal scalars in the order of Winter, Spring, Summer and Fall. If the QFLG (or ISW(23)) parameter has a value of "2", enter 12 monthly scalar values beginning with January and ending with December. If the value equals "3", enter 24 scalar values for each hour of the day beginning with the first hour and ending with the twenty-fourth hour. If the value equals "4", enter six sets of scalar values for the six wind speed categories for a total of 36 scalar values. Each of the six sets of scalar values represents a Pasquill stability beginning with category A and ending with category F. Each set is started on a new card image. If the value equals "5", four sets of scalar values are entered where each set contains 24 hourly values (analogous to a value equal to "3" option) for a total of 96 scalar values. The four sets of scalar values represents the four seasons in the order of Winter, Spring, Summer and Fall. Each set is started on a new card image.

f. Hourly Meteorological Data. These data may be entered in one of two formats (governed by the value entered in parameter ISW(19)). One format is that generated by the preprocessor program (see Appendix G). This format usually resides on magnetic tape where the tape device is externally associated with the logical unit specified by parameter IMET. All hourly data required by the program are contained on the tape. The other format is card image. The following data are required for each hour only when the card image format is chosen by the user.

Parameter Name	
JDAY	Julian Day -- This parameter specifies the Julian Day of this day of meteorological data. This parameter is read by the program for only the first hour of data for each day. This parameter is ignored for the second and successive hours of each day of data. This parameter is used by the program to determine the month or season if required by other program options. The default value equals "1" (Julian Day 1).
AFV	Wind Flow Vector -- This parameter specifies the direction (degrees) toward which the wind is blowing.
AWS	Wind Speed -- This parameter specifies the mean wind speed (meters/second) measured at the reference height specified in parameter ZR.
HLH	Mixing Height -- This parameter specifies the height of the top of the surface mixing layer (meters).
TEMP	Ambient Air Temperature -- This parameter specifies the ambient air temperature (degrees Kelvin).

Parameter Name	
DTHDZ	Vertical Potential Temperature Gradient (Optional) -- This parameter specifies the vertical potential temperature gradient (degrees Kelvin/meter) for a given hour. The value for this parameter is used by the program only if parameter ISW(22) equals "3".
IST	Pasquill Stability Category -- This parameter specifies the Pasquill stability category. A value of "1" equals category A, "2" equals B, "3" equals C, etc.
P	Wind Profile Exponent (Optional) -- This parameter specifies the wind profile exponent for a given hour. The value for this parameter is used by the program only if parameter ISW(21) equals "3".
DECAY	Decay Coefficient -- This parameter specifies the decay coefficient (seconds^{-1}) for chemical or other removal processes for a given hour. This parameter overrides any value entered in parameter DECAY described earlier in Section 3.1.2.b. The default value equals "0" for no decay.

3.1.3 Output Information

The ISCST program generates six categories of program output. Each category is optional to the user. That is, the user controls what output the program generates for a given problem run. In the following paragraphs, each category of output is related to the input parameter that controls the output category. All program output are printed except for the magnetic tape output.

a. Input Parameter Output. The user may desire to see all input parameters used by the program. If input parameter ISW(6) equals "1", the program will print all program control input parameters, meteorological-related and information constants, receptor data and source data. Additionally, if parameter ISW(6) equals "2", the program will also print all hourly meteorological data processed by the program for a given problem run.

b. Daily Concentration (Deposition) Output. This category of output prints calculated values of average concentration or total deposition for each day of meteorological data processed by the program for a given problem run. For each day, tables consisting of average concentration or total deposition values at each receptor point are printed for all combinations of user-defined time periods and source groups. For example, suppose combinations of 1-, 3- and 24-hour time periods and five source groups (NGROUP equals "5") are specified and input parameter IPERD equals "0". Thirty-three tables would be generated by all time period intervals (24 1-hour tables, eight 3-hour tables and one 24-hour table) for a total of 165 tables for all source groups for each day of meteorological data. Input parameters ISW(7) through ISW(14) and IPERD specify the time periods and time period interval, respectively, for which average concentration or total deposition values are printed. The source group combinations are specified by input parameters NGROUP, NSOGRP and IDSOR. Input parameter ISW(16) controls the employment of this output category.

c. "N"-Day Concentration (Deposition) Output. This category prints the average concentration or total deposition calculated over the number of days ("N") of meteorological data processed by a given problem run. Tables consisting of average concentration or total deposition values at each receptor point are printed for all source group combinations defined by the user with input parameters NGROUP, NSOGRP and IDSOR. Input parameter ISW(15) specifies the use of this output category.

d. Highest and Second-Highest Concentration (Deposition) Output. This category prints tables of the highest and second-highest average concentration or total deposition values calculated at each receptor point. Tables are produced for all user-defined combinations of time periods and source groups. For example, suppose 3- and 8-hour time periods and ten source groups (NGROUP equals "10") are specified. Twenty-two tables would be produced by all time periods (tables of highest values and tables of second-highest values) for a total of 220 tables for all source groups for the example problem run. Input parameters ISW(7) through ISW(14), and NGROUP, NSOGRP and IDSOR provide user control of the desired time periods and source groups, respectively. The employment of this output category is controlled by input parameter ISW(17).

e. Maximum 50 Concentration (Deposition) Output. This category produces tables of the maximum 50 average concentration or total deposition values calculated for the problem run. Each table prints the maximum 50 values including when and at which receptor each value occurred. Tables are printed for all user-defined combinations of time periods and source groups which are specified by input parameters ISW(7) through ISW(14), and NGROUP, NSOGRP and IDSOR, respectively. Input parameter ISW(18) controls the use of this output category.

f. Tape Concentration (Deposition) Output. This category writes the results of average concentration or total deposition calculations to a magnetic tape whose tape device is linked to the program through input parameter ITAP. If ISW(5) equals "1", the program writes to tape records of the average concentration or total deposition values for all user-defined combinations of time periods and source groups for each day of meteorological data processed by the program. Each tape record includes the average concentration or total deposition values calculated at each receptor point. Also, all concentration or deposition values generated by the "N"-day output option (see category c above) are written to tape only if the "N"-day output option (ISW(15)) is exercised by the user.

An illustration of each of the above print output categories is shown in Section 3.2.4. Also discussed is the order in which the tables and tape records are generated for each output category.

3.2 USER'S INSTRUCTIONS FOR THE ISCST PROGRAM

3.2.1 Program Description

The ISC short-term (ISCST) program is designed to use hourly meteorological data to calculate ground-level concentration or deposition values produced by emissions from multiple stack, volume and area sources. The receptors at which concentration or deposition values are calculated may be defined on a (X, Y) right-handed Cartesian coordinate system grid or an (r, θ) polar coordinate system grid. The polar coordinate system defines 360 degrees as north (positive Y-axis), 90 degrees as east (positive X-axis), 180 degrees as south and 270 degrees as west. Discrete or arbitrarily placed receptors may also be defined by the user using either type of coordinate system. This program also has the user option of assigning elevations above mean sea level to each source and receptor. The stack, volume or area sources may be individually located anywhere, but must be referenced using a Cartesian coordinate system relative to the origin of the receptor coordinate system.

Average concentration or total deposition values may be calculated for 1-, 2-, 3-, 4-, 6-, 8-, 12- or 24-hour time periods. "N"-day average concentration or total deposition values for the total number of days of meteorological data processed by the program may also be computed for each receptor. Average concentration or total deposition values may be printed for source groups, where a source group consists of any user-defined combination of sources.

The ISCST program accepts hourly meteorological input data in either of two options. One option reads hourly meteorological data from a magnetic tape unit or other similar external input device. These data are read in a format compatible with the meteorological data format generated by the preprocessor program (see Appendix G). The other option reads hourly meteorological data from cards in a card image format.

The ISCST program produces several categories of output of calculated concentration or deposition values. All categories of output are optional to the user. Average concentration or total deposition values may be printed for all receptors for all combinations of time intervals and source groups for any number of days of meteorological data. The average concentration or total deposition values calculated over an "N"-day period may be printed for all source groups defined by the user. Also, the highest and second-highest average concentration or total deposition values calculated at each receptor for all combinations of time periods and source groups may be printed. The maximum 50 calculated average concentration or total deposition values may also be printed for all combinations of time periods and source groups defined by the user. The program may also generate an output tape file consisting of all calculated concentration or deposition values for each receptor for each user-defined combination of time periods and source groups for each day of meteorological data processed by the program. Additionally, all average concentration or total deposition values calculated over an "N"-day period may be written to the output tape file for all user-defined source groups.

The ISCST program is written in FORTRAN IV. Its design assumes that 4 Hollerith characters can be stored in a computer word. The basic program requires about 21,500 UNIVAC 1100 Series 36-bit words. Another 43,500 words of data storage are currently allocated for a total of 65,000 computer words. With this current allotment of executable storage, the program may be run with up to 400 receptors and 100 sources. The card reader or input device to this program is referenced as FORTRAN logical unit 5 and the printer or output device as logical unit 6. The

ISCST program is composed of a main program (ISCST), nine subroutines (INCHK, MODEL, DYOUT, MAXOT, MAX50, VERT, SIGMAZ, UPWIND and ERFX) and a BLOCK DATA subprogram (BLOCK). The source codes for all of these routines are listed in Appendix A. Appendix H contains a logic flow description of the ISCST program.

3.2.2 Control Language and Data Deck Setup

a. Control Language Requirements. The following example illustrates the required control statement runstream for a typical run on a UNIVAC 1100 Series Operating System:

```
@RUN   ISCST, . . .
@ASG,A PROGFILE.
@ASG,A METFILE.
@USE 9,METFILE.
@ASG,CP OUTPUTFILE.}
@USE 3,OUTPUTFILE. }   Optional, required only if ISW(5) = 1
@XQT PROGFILE.ABSISCST
 Card input data deck
@FIN
```

The first control statement initiates the runstream with job name ISCST where the parameters following the job name may vary with each computer installation. The second control statement assigns the existing program file PROGFILE to the run. It is assumed that this file contains the absolute element (executable version) of the program. The third and fourth control statements assign an existing meteorological data input file METFILE and associate FORTRAN logical unit number 9 with the meteorological file. These control statements may be optional if the user has provided meteorological data in the card input data deck (accompanying the card input data). However, most cases require a meteorological data file which is external to the card input data. The fifth and sixth control statements create an optional output data file OUTPUTFILE for saving calculated concentration or deposition values and associate FORTRAN logical unit number 3 with the output data file. These control statements are required only if parameter ISW(5) equals "1". The ISCST program is ready to execute as performed by the seventh control statement. All card input data required for the problem run immediately follows the execute card. The final control card terminates the runstream.

The following job control statement runstream is given for a typical run on an IBM 360 Operating System:

```
//ISCST JOB(12345),'TYPICAL RUNSTREAM'
//JOBLIB DD DSNAME=PROGFILE,DISP=(OLD,PASS)
//STEP1 EXEC PGM=ABSISCST
//FT05F001 DD DDNAME=SYSIN
//FT06F001 DD SYSOUT=A
//FT09F001 DD DSN=METFILE,UNIT=TAPE,
//            VOL=SER=METTP,DCB=RECFM=V,
//            DISP=OLD
//FT03F001 DD DSN=OUTPUTFILE,UNIT=TAPE,  )
//            VOL=SER=SAVTP,DCB=RECFM=V, }   Optional,
//            DISP=(NEW,KEEP)            )   required only
                                             if ISW(5)=1.
//GO.SYSIN DD*
  Card input data deck
//
```

The first job control statement initiates the runstream with job identification ISCST and account number 12345. The second and third control statements obtain the library file PROGFILE in which the absolute, executable deck ABSISCST is located. The fourth and fifth control statements link FORTRAN logical unit numbers 05 and 06 as the card reader and printer, respectively. Control statement six defines an existing meteorological data input tape file METFILE with a reel identification of METTP and links

FORTRAN logical unit 09 with the meteorological file. This file is usually required in a job runstream unless the hourly meteorological data are contained in the card input data deck. Control statement seven defines a new output tape file OUTPUTFILE with a reel identification of SAVTP and links FORTRAN logical unit number 03 with the output file. This output file is optional and is required only if parameter ISW(5) equals "1". The program is executed by control card eight which is immediately followed by the card input data deck. The null statement at the end terminates the job runstream.

Another example of the required control statements is shown for use on a CDC 6500 Operating System:

```
ISCST,,,.
REQUEST,TAPE09,VRN=METTP,HY.
REQUEST,TAPE03,VRN=SAVTP,RW,HY.     {Optional, required only
                                    {     if ISW(5) = 1.
ATTACH,ABSISCST,PROGFILE.
ABSISCST.
7/8/9 multipunch in card column one
  Card input data deck
6/7/8/9 multipunch in card column one
```

The first control statement identifies the job name as ISCST where other parameters may be used if desired. The second control statement requests an input tape where the assigned file name TAPE09 is defined as an input file and is linked to FORTRAN logical unit number 9 by a CDC FORTRAN program control card. This statement is required only if the hourly meteorological data are not included in the card input data deck. The third control statement requests an output tape where the assigned file name TAPE03 is defined as an output file and is linked to FORTRAN logical unit number 3 by a CDC FORTRAN program control card. This control statement is required only if parameter ISW(5) equals "1". The fourth control statement accesses the permanent program file PROGFILE and assigns the local file name ABSISCST to the runstream. It is assumed that PROGFILE is an executable version of the ISCST program. The fifth control statement executes the ISCST program. An end-of-record follows as indicated by the 7/8/9 multipunch in column one, which separates the control statements from the card input data deck. The 6/7/8/9 multipunch in column one terminates the control statement runstream.

Regardless of the operating system, the control statement runstream serves three primary functions. First, all necessary program, input and output data files must be assigned or created. Second, FORTRAN logical unit numbers must be associated with all data files so that the ISCST program can reference the data files through the use of the logical unit number parameters (IMET and ITAP). Third, the ISCST program is executed with an accompanying card input data deck.

b. Data Deck Setup. The card input data required by the ISCST program depends on the program options desired by the user. The card input data may be partitioned into seven major groups of card input. Figure 3-1 illustrates the input deck setup. The seven card input deck groups are itemized below:

(1) Title Card (1 card)
(2) Program Control Cards (2 cards)
(3) Receptor Cards
(4) Source Group Data Cards (optional, required only if NGROUP > 0)
(5) Meteorological-Related and Model Constants Cards
(6) Source Data Cards
(7) Hourly Meteorological Data Cards (optional, required only if ISW(19) = 2)

An example card input data deck for the ISCST program is presented in Appendix C. A description of the input format and contents of each of the seven card groups is provided below in Section 3.2.3.a.

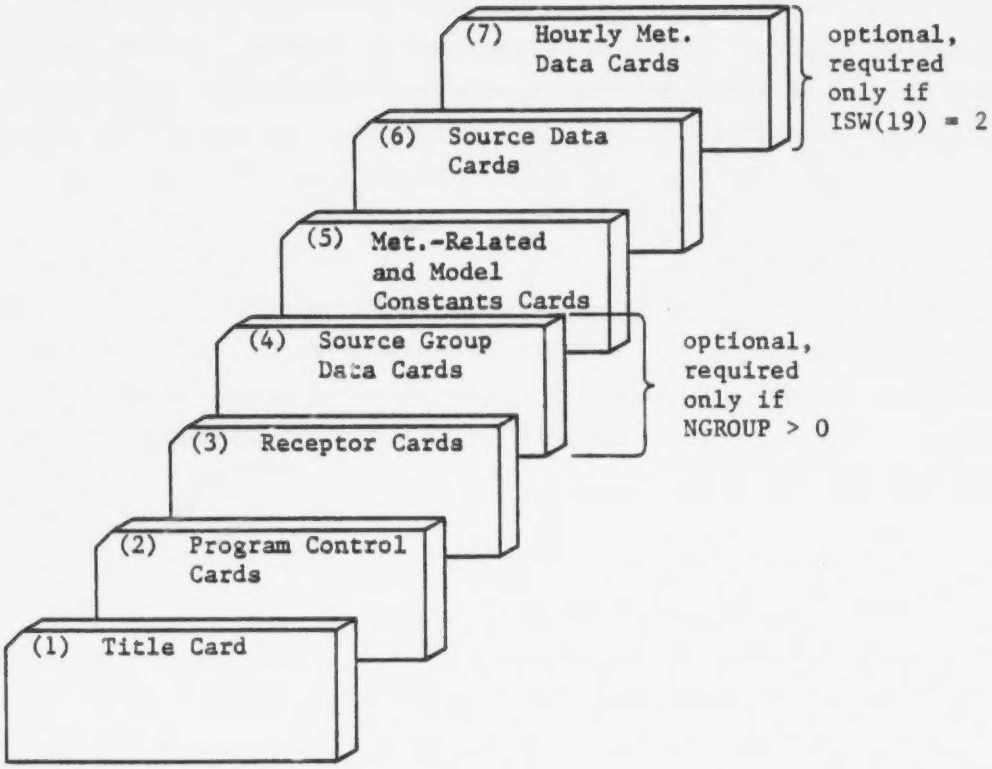
(7) Hourly Met. Data Cards
optional, required only if ISW(19) = 2
(6) Source Data Cards
(5) Met.-Related and Model Constants Cards
(4) Source Group Data Cards
optional, required only if NGROUP > 0
(3) Receptor Cards
(2) Program Control Cards
(1) Title Card

FIGURE 3-1. Input data deck setup for the ISCST program.

3.2.3 Input Data Description

Section 3.1.2 provides a summary description of all input data requirements of the ISCST program. This section provides the user with the format and order in which the program requires the input data. The input parameter names used in this section correspond to those used in Section 3.1.2. Two forms of input data are read by the program. One form is card image input data (80 characters per record) in which all required input data may be entered. The other form is magnetic tape which contains hourly meteorological data in a format generated by the preprocessor program. Both forms are discussed below.

a. Card Input Requirements. The ISCST program reads all card image input data in a fixed-field format with the use of FORTRAN "A", "I", "F" and "E" editing codes. The card input data are partitioned into seven card groups which are discussed in Section 3.2.2.b and shown in Figure 3-1. The input parameters contained in Card Groups (2) and (4) correspond with those described in category "a" of Section 3.1.2. Moreover, Card Groups (1) and (5) correspond with categories "b" and "c", Group (3) with category "d", Group (6) with category "e" and Group (7) with category "f". Table 3-4 is a list of all card image input data which may be entered. For each input parameter, Table 3-4 provides the Card Group (and the card number within the Card Group, if possible), parameter name, card columns within which the value of the input parameter must reside, FORTRAN editing code and a brief description which includes default values or maximum values allowed, if applicable. The order in which the input parameters are listed in Table 3-4 is the order in which the ISCST program reads the input parameters. The user should note that many card input parameters and even entire Card Groups are ignored or not read by the program, depending on the options chosen by the user.

Card Groups (1) and (2) consist of a total of three cards. Card Group (1) consists of one card and contains the parameter TITLE.

TABLE 3-4

ISCST PROGRAM CARD INPUT PARAMETERS, FORTRAN EDIT CODE (FORMAT) AND DESCRIPTION

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
1	TITLE	1-60	15A4	60-character heading label
2, 1	ISW(1)	1-2	I2	1 = calculate concentration 2 = calculate deposition Default assumes 1
2, 1	ISW(2)	3-4	I2	1 = Cartesian coordinate receptor grid system 2 = polar coordinate receptor grid system 3 = program generates Cartesian coordinate grid 4 = program generates polar coordinate grid Default assumes 1
2, 1	ISW(3)	5-6	I2	1 = discrete receptors referenced with Cartesian coordinate system 2 = discrete receptors referenced with polar coordinate system Default assumes 1
2, 1	ISW(4)	7-8	I2	0 = no receptor terrain elevations are input 1 = program reads receptor terrain elevations Default assumes 0
2, 1	ISW(5)	9-10	I2	0 = no output tape containing concentration or deposition values is written

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2, 1	ISW(5) (Cont.)	9-10	I2	1 = output tape containing concentration or deposition values is written to tape on logical unit ITAP Default assumes 0
2, 1	ISW(6)	11-12	I2	0 = no input data are printed 1 = print all input data except hourly meteorology data 2 = same as 1 but hourly meteorological data are also printed Default assumes 0
2, 1	ISW(7)	13-14	I2	0 = no 1-hour time periods 1 = 1-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(8)	15-16	I2	0 = no 2-hour time periods 1 = 2-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(9)	17-18	I2	0 = no 3-hour time periods 1 = 3-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(10)	19-20	I2	0 = no 4-hour time periods 1 = 4-hour average concentration or total deposition calculated Default assumes 0

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2, 1	ISW(11)	21-22	I2	0 = no 6-hour time periods 1 = 6-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(12)	23-24	I2	0 = no 8-hour time periods 1 = 8-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(13)	25-26	I2	0 = no 12-hour time periods 1 = 12-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(14)	27-28	I2	0 = no 24-hour time period 1 = 24-hour average concentration or total deposition calculated Default assumes 0
2, 1	ISW(15)	29-30	I2	0 = print no "N"-day output tables 1 = print "N"-day average concentration or total deposition output tables Default assumes 0
2, 1	ISW(16)	31-32	I2	0 = print no daily time period tables 1 = print daily average concentration or total deposition tables for each time period and source group for each day of meteorological data Default assumes 0

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2, 1	ISW(17)	33-34	I2	0 = print no highest and second highest tables 1 = print highest and second highest average concentration or total deposition calculated at each receptor for each time period and source group Default assumes 0
2, 1	ISW(18)	35-36	I2	0 = print no maximum 50 tables 1 = print the maximum 50 average concentration or total deposition values calculated for each time period and source group Default assumes 0
2, 1	ISW(19)	37-38	I2	1 = hourly meteorological data is read from logical unit IMET in a preprocessed format 2 = hourly meteorological data is read from cards Default assumes 1
2, 1	ISW(20)	39-40	I2	0 = Rural Mode Option 1 = Urban Mode-1 Option 2 = Urban Mode-2 Option Default assumes 0
2, 1	ISW(21)	41-42	I2	1 = program provides default wind profile exponent values 2 = user enters 36 wind profile exponents for 6 wind speed and 6 stability categories in Card Group 5 below

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format	Description
2, 1	ISW(21) (Cont.)	41-42	I2	3 = user enters hourly wind profile exponents in Card Group 7 below Default assumes 1
2, 1	ISW(22)	43-44	I2	1 = program provides default vertical potential tempterature gradient values 2 = user enters 36 vertical potential temperature gradients for 6 wind speed and 6 stability categories 3 = user enters hourly vertical potential temperature gradients in Card Group 7 below Default assumes 1
2, 1	ISW(23)	45-46	I2	0 = emission rates for all sources do not vary 1 = emission rates vary seasonally for all sources 2 = emission rates vary monthly for all sources 3 = emission rates vary each hour per day for all sources 4 = emission rates vary by wind speed and stability category for all sources 5 = emission rates vary seasonally and each hour per day Default assumes 0. A zero value entered for this parameter allows the user to vary emission rates for individual sources by the use of input parameter QFLG

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2, 1	ISW(24)	47-48	I2	1 = program uses final plume rise for all receptor locations 2 = program computes plume rise as a function of the receptor location Default assumes 1
2, 1	ISW(25)	49-50	I2	1 = physical stack heights are not modified to account for downwash 2 = physical stack heights are modified to account for stack downwash Default assumes 1
2, 2	NSOURC*	1-6	I6	Number of sources
2, 2	NXPNTS*	7-12	I6	Number of grid points in the X-axis or number of ranges (rings) for the receptor grid. A zero value implies no receptor grid
2, 2	NYPNTS*	13-18	I6	Number of grid points in the Y-axis or number of direction radials for the receptor grid. A zero value implies no receptor grid
2, 2	NXWYPT*	19-24	I6	Number of discrete receptor points. A zero value implies no discrete receptor points

*See Equation (3-1) for the maximum value allowed by the program for this input parameter

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2, 2	NGROUP	25-30	I6	Number of source group combinations. A zero value assumes one source group which consists of all sources. Maximum number = 150
2, 2	IPERD	31-36	I6	Print "N"th time interval only for all time periods specified for daily table output. Enter "N" in this parameter. Default assumes all intervals for each desired time period are printed. This parameter is ignored if ISW(16) = 0
2, 2	NHOURS	37-42	I6	Enter number of hours per day of meteorological data. This parameter is ignored if ISW(19) = 1
2, 2	NDAYS	43-48	I6	Enter number of days of meteorological data. This parameter is ignored if ISW(19) = 1
3, 1	GRIDX	1-80	8F10.0	This parameter is not read if NXPNTS or NYPNTS equals 0. Enter NXPNTS X-axis (ISW(2) = 1) or NXPNTS range (ISW(2) = 2 or 4) receptor grid locations (meters). If ISW(2) = 3, enter the

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
3, 1	GRIDX (Cont.)	1-80	8F10.0	starting X-axis grid location in columns 1-10 and the incremental value in columns 11-20 (meters).
3, 2	GRIDY	1-80	8F10.0	This parameter is not read if NXPNTS or NYPNTS equals 0. Enter NYPNTS Y-axis (ISW(2) = 1) receptor grid locations (meters) or NYPNTS direction radial (ISW(2) = 2) locations in integer degrees within the range of 1 to 360 degrees. If ISW(2) = 3, enter the starting axis grid location (meters) in columns 1-10 and the incremental value in columns 11-20 (meters). If ISW(2) = 4, enter the starting direction radial location in columns 1-10 and the incremental value in columns 11-20. Enter values which generate integer directions within the range of 1 to 360 degrees.
3, 3	XDIS	1-80	8F10.0	This parameter is not read if NXWYPT = 0. Enter NXWYPT X (ISW(3) = 1) or range ISW(3) = 2) discrete receptor locations (meters).
3, 4	YDIS	1-80	8F10.0	This parameter is not read if NXWYPT = 0. Enter NXWYPT discrete Y receptor locations

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
3, 4	YDIS (Cont.)	1-80	8F10.0	in meters (ISW(3) = 1) or NXWYPT discrete direction receptor locations in integer degree values (ISW(3) = 2) within the range of 1 to 360 degrees.
3, 5	GRIDZ	1-80	8F10.0	This parameter, which is an array defining receptor elevations (feet MSL), is not read if ISW(4) = 0. For the regular receptor grid (if any), receptor elevation Z_{ij} corresponds to the i^{th} X coordinate (range) and j^{th} Y coordinate (direction radial). Begin with Z_{11} and enter NXPNTS values (Z_{11}, Z_{21}, Z_{31}, ...). Then, starting with a new card image, enter NXPNTS values (Z_{12}, Z_{22}, Z_{32}, ...). Continue until all regular receptor elevations have been entered. For the discrete receptor locations (if any), enter NXWYPT elevation values, beginning with a new card image, in the order the discrete receptor locations were entered in XDIS and YDIS.
4*, 1	NSOGRP	1-80	20I4	Enter the number of source identification numbers required to define a source group for each source group combination. Enter NGROUP values. A maximum of 150 values may be entered.

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
4*, 2	IDSOR	1-78	13I6	Enter the source identification numbers used to define a source group for each source group combination. A minus sign preceding a source identification number implies inclusive summing from the previous source number entered to the source number with the minus sign. A maximum of 200 values may be entered.
5, 1-6	PDEF	1-60	6F10.0	This parameter is read only if ISW(21) = 2. Enter 36 wind profile exponents. For each of the six Pasquill stability categories, enter 6 values per card for each of the 6 wind speed categories.
5, 7-12	DTHDEF	1-60	6F10.0	This parameter is read only if ISW(22) = 2. Enter 36 vertical potential temperature gradients (degrees Kelvin/meter). For each of the six Pasquill stability categories, enter 6 values per card for each of the 6 wind speed categories.
5, 13	ZR	1-10	F10.0	Enter the wind speed reference height z_1 (meters). Default assumes 10.0 meters.
5, 13	UCATS	11-60	5F10.0	Enter the upper bound of the first through fifth wind speed categories (meters/second). Default assumes 1.54, 3.09, 5.14, 8.23 and 10.8 meters per second.

*This card group is not read if parameter NGROUP equals 0.

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
5, 14	TK	1-8	E8.0	Enter the source emission rate conversion factor in order to convert the emission rate units. Default assumes 1.0 x 10^6 for concentration and 1.0 for deposition.
5, 14	BETA1	9-16	F8.0	Enter the adiabatic entrainment coefficient. Default assumes 0.6 (Briggs, 1975).
5, 14	BETA2	17-24	F8.0	Enter the stable entrainment coefficient. Default assumes 0.6 (Briggs, 1975).
5, 14	DECAY	25-32	F8.0	This parameter is ignored if ISW(19) = 2. Enter the decay coefficient (seconds^{-1}) for chemical depletion of a pollutant. Default assumes no decay.
5, 14	IQUN	33-44	3A4	A 12-character label identifying the emission rate units of all sources. Default assumes (grams/second) for concentration and (grams) for deposition. Units of per square meter are automatically included for area sources.
5, 14	ICHIUN	45-72	7A4	A 28-character label identifying the units of concentration or deposition. Default assumes (micrograms/cubic meter) for concentration and (grams/square meter) for deposition.
5, 14	IMET	73-74	I2	FORTRAN logical unit number of hourly meteorological data. Default assumes "9" if ISW(19) = 1 and "5" (or current read unit) if ISW(19) = 2.

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
5, 14	ITAP	75-76	I2	FORTRAN logical unit number of concentration or deposition output tape. Default assumes "3".
5, 15-19	IDAY	1-80	80I1	This parameter is not read if ISW(19) = 2. This parameter consists of an array of 366 entries where each entry corresponds to the 366 Julian Days in a year. An entry set to "1" indicates that the corresponding Julian Day will be processed by the program. For example, if IDAY(140) = 1 then Julian Day 140 will be processed by the program. Default assumes 0 for all days.
5, 20	ISS	1-6	I6	This parameter is not read if ISW(19) = 2. Enter the surface station number of the hourly meteorological data. This number must match the station number read from the meteorological tape.
5, 20	ISY	7-12	I6	This parameter is not read if ISW(19) = 2. Enter the year (last two digits only) of the surface station meteorological data. The year must match the corresponding year read from the meteorological tape.
5, 20	IUS	13-18	I6	This parameter is not read if ISW(19) = 2. Enter the upper air station number of the hourly meteorological data. The number must match the station number read from the meteorological tape.

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
5, 20	IUY	19-24	I6	This parameter is not read if ISW(19) = 2. Enter the year (last two digits only) of the upper air station meteorological data. The year must match the corresponding year read from the meteorological tape.
6, 1*	NSO	1-5	I5	Enter a unique source identification number for the problem run. Must be a positive integer.
6, 1*	ITYPE	6	I1	0 = stack-type source 1 = volume-type source 2 = area-type source
6, 1*	WAKE	7	I1	This parameter pertains only to stack-type sources with building wake effects. If 0 is entered or left blank, an "upper bound" concentration or deposition is calculated. If 1 is entered, a "lower bound" concentration or deposition is calculated (see Section 2.4.1.1.d).
6, 1*	NVS	8-9	I2	Enter the number of gravitational settling categories. Maximum number allowed = 20. Default assumes 0.
6, 1*	QFLG	10	I1	This parameter is ignored if ISW(23) > 0. Enter emission rate variation indicator. See input parameter ISW(23) for options. Default assumes 0.

*This card is repeated for each source (NSOURC times).

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
6, 1*	Q	11-18	F8.0	Enter emission rate. For concentration and type 0 and 1 sources, units are mass per time and for type 2 sources, units are mass per square meter per time. For deposition and type 0 and 1 sources, units are in mass and for type 2 source units are in mass per square meter.
6, 1*	XS	19-25	F7.0	X-coordinate (east-west location) in meters of the center of a stack or volume source and the southwest corner of an area source.
6, 1*	YS	26-32	F7.0	Y-coordinate (north-south location) in meters of the center of a stack or volume source and the southwest corner of an area source.
6, 1*	ZS	33-38	F6.0	Elevation of the source at the source base (meters above mean sea level).
6, 1*	HS	39-44	F6.0	Enter source height (meters). For type 0 sources, enter stack height; for type 1 sources, enter height at the center of the volume source; for type 2 sources, enter the effective emission height.
6, 1*	TS	45-50	F6.0	For type 0 sources, enter the stack exit temperature (degrees Kelvin); for type 1 sources, enter the initial vertical dimension σ_{zo} in meters.

*This card is repeated for each source (NSOURC times).

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
6, 1*	VS	51-56	F6.0	For type 0 sources, enter the stack exit velocity (meters per second); for type 1 sources, enter the initial horizontal dimension σ_{yo} in meters; for type 2 sources, enter the width (meters) of a square area source.
6, 1*	D	57-62	F6.0	For type 0 sources, enter the inner stack diameter (meters).
6, 1*	HB**	63-68	F6.0	For type 0 sources, enter the height (meters) of a building adjacent to this stack source.
6, 1*	HL**	69-74	F6.0	For type 0 sources, enter the length (meters) of a building adjacent to this stack source.
6, 1*	HW**	75-80	F6.0	For type 0 sources, enter the width (meters) of a building adjacent to this stack source.
6, 2*	PHI	1-80	8F10.0	This parameter is not read if NVS equals zero from card 1 for a given source. Enter the mass fraction of particulates for each gravitational settling category. Enter NVS values.

*This card is repeated for each source (NSOURC times).

**If non-zero values are entered for parameters HB or HL and HW, the program automatically uses the building wake effects option (see Section 2.4.1.1.d). However, if HB, HL, and HW are not punched or are equal to "0," wake effects for the respective source are not considered.

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
6, 3*	VSN	1-80	8F10.0	This parameter is not read if NVS equals zero from card 1 for a given source. Enter the gravitational settling velocity (meters per second) for each gravitational settling category. Enter NVS values.
6, 4*	GAMMA	1-80	8F10.0	This parameter is not read if NVS equals zero from card 1 for a given source. Enter the surface reflection coefficient for each gravitational settling category. Enter NVS values.
6, 5**	QTK	1-80	8F10.0	Enter the source emission rate scalars in a manner depending on the value of ISW(23) or QFLG (whichever parameter is applicable). If ISW(23) or QFLG = 1 enter 4 seasonal scalars in the order of winter, spring, summer and fall (1 card); if = 2, enter twelve monthly scalars beginning with January and ending with December (2 cards); if = 3, enter 24 scalars for each hour of the day (3 cards); if = 4, enter 6 scalars per card for each wind speed category and 6 cards for each of the six Pasquill stability categories (A-F) (6 cards); and if = 5, enter 24 hourly scalars for each of the four seasons (12 cards).

*This card is repeated for each source (NSOURC times).

**This card is not read if ISW(23) = 0 and QFLG = 0 for all sources. Otherwise if ISW(23) > 0 then this card is read once; if ISW(23) = 0, this card is read for each source for which QFLG > 0.

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
7*, 1**	JDAY	6-8	I3	Enter the Julian Day of this day of hourly meteorological data. This is used to compute the season or month if required for any sources which have variational emission rates.
7*, 1**	AFV	9-16	F8.0	Enter the direction (degrees) toward which the wind is blowing. This value is also used as the random wind flow vector by the model.
7*, 1**	AWS	17-24	F8.0	Enter the mean wind speed (meters per second) measured at reference height z_1.
7*, 1**	HLH	25-32	F8.0	Enter the height of the top of the surface mixing layer (meters).
7*, 1**	TEMP	33-40	F8.0	Enter the ambient air temperature (degrees Kelvin).
7*, 1**	DTHDZ	41-48	F8.0	This parameter is read only if ISW(22) = 3. Enter the vertical potential temperature gradient (degrees Kelvin per meter).
7*, 1**	IST	56	I1	Enter the Pasquill stability category (1 = A, 2 = B, 3 = C, etc.)

*This card group is not read if ISW(19) = 1. If ISW(19) = 2, this card group is repeated NDAYS times.

**This card is repeated for each hour of the day (NHOURS times).

TABLE 3-4 (Continued)

Card Group, Card Number	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
7*, 1**	P	57-64	F8.0	This parameter is read only if ISW(21) = 3. Enter the wind profile exponent.
7*, 1**	DECAY	65-72	F8.0	Enter the decay coefficient (seconds^{-1}) for chemical removal of a pollutant for this hour. Default assumes no decay. This value overrides any value entered in parameter DECAY in Card Group 5.

*This card group is not read if ISW(19) = 1. If ISW(19) = 2, this card group is repeated NDAYS times.

**This card is repeated for each hour of the day (NHOURS times).

Card Group (2) consists of the "ISW" array which contains most of the program's control or specification parameters. Also contained in Card Group (2) are parameters which specify the number of sources (NSOURC), the size of the receptor grid (NXPNTS and NYPNTS), the number of discrete receptors (NXWYPT) and the number of source group combinations (NGROUP). The maximum number of sources and receptors is not limited to individual parameters but is a function of four parameters. This function can be described as

$$\begin{aligned}\mathrm{LIMIT} \geq\ & \mathrm{NPNTS} \cdot (\mathrm{NAVG} \cdot \mathrm{NGROUP} + 2) + \mathrm{NXPNTS} + \mathrm{NYPNTS} \\ & + 2 \cdot \mathrm{NXWYPT} + 215 \cdot \mathrm{NSOURC} + A + B + C\end{aligned} \tag{3-1}$$

where

NSOURC = number of input sources (see card columns 1-6 of the second card of Card Group (2))

NXPNTS = number of X points or ranges in the receptor grid (see card columns 7-12 of the second card of Card Group (2))

NYPNTS = number of Y points or direction radials in the receptor grid (see card columns 13-18 of the second card of Card Group (2))

NXWYPT = number of discrete receptors (see card columns 19-24 of the second card of Card Group (2))

NPNTS = NXPNTS · NYPNTS + NXWYPT (total number of receptors)

NAVG = number of time periods. This equals the number of time period parameters (ISW(7) through ISW(14) in the first card of Card Group (2)) set to "1"

NGROUP = number of source group combinations (see card columns 25-30 of the second card of Card Group (2)). For the purpose of computing the required data storage for a problem run, assume NGROUP equals "1" in Equation (3-1) if NGROUP equals "0" in Card Group (2)

A = NPNTS • NGROUP if ISW(15) equals "1" in the first card of Card Group (2); otherwise A equals "0"

B = 4 • NAVG • NPNTS • NGROUP if ISW(17) equals "1" in the first card of Card Group (2); otherwise B equals "0"

C = 201 • NAVG • NGROUP if ISW(18) equals "1" in the first card of Card Group (2); otherwise C equals "0"

and

LIMIT = 43,500. This is the current data storage allocation of the program (consult Section 3.2.7 for modification of this value)

Card Group (3) consists of parameters which contain the receptor location information. If the user chooses not to define a receptor grid (either NXPNTS or NYPNTS = "0"), the program does not read parameters GRIDX and GRIDY. Likewise, parameters XDIS and YDIS are not read by the program if the user chooses not to specify any discrete receptors (NXWYPT ="0"). All receptor location values are entered in a continuous manner with 8 values per card image in fields of 10 columns. Begin a new card image for each parameter input (GRIDX, GRIDY, XDIS and YDIS). Similarly, all receptor terrain elevations are entered into parameter GRIDZ (if ISW(4) equals "1" in Card Group (2)), with 8 values per card in 10 column-wide fields. A new card image is started, though, for each set of X-axis (range) locations entered per Y-axis point (radial). This format is described in Table 3-4 and Section 3.1.2.d.

Card Group (4) contains the parameters which define what sources constitute each source group combination. This Card Group is not read by the program if NGROUP equals "0" in the second card of Group (2). Parameter NSOGRP reads up to 20 integer values per card in 4-column fields. Parameter IDSOR reads up to 13 integer values per card in 6-column fields.

Card Group (5) consists of meteorological-related parameters which remain constant once they are set, and identification labels and model constants. The first parameter in this Card Group (PDEF) consists of six cards, and is read by the program only if ISW(21) equals "2" in Card Group (2). Likewise, the second parameter (DTHDEF) consists of six cards, and read by the program only if ISW(22) equals "2". The following two cards (cards 13 and 14) are read by the program and contain parameters which have program-provided default values as indicated in Table 3-4. The user should note that the default values of the units conversion factor (TK), the units label for source emission rates (IQUN) and the units label for concentration or deposition (ICHIUN) are compatible. That is, the default mass units of the source emission rates (grams) is scaled by the default conversion value which is compatible with the default mass units of concentration (micrograms) or deposition (grams). Cards 15 through 19 in this Card Group consist of the IDAY parameter. IDAY is not read by the program if ISW(19) equals "2" in Card Group (2). This parameter is an array where each column on the 80-column card image for each card represents a Julian Day. For example, to indicate that Julian Day 140 of the hourly meteorological data is to be processed by the program, IDAY(140) is set to "1" which is column 60 of the second card of the IDAY parameter. The remaining parameters consist of one card (the 20th possible card of this Card Group) and are not read if ISW(19) equals "2" in Card Group (2).

Card Group (6) contains all source data parameters. Except for the last parameter (card 5) in this Card Group (QTK), this Card Group is repeated for each source input (NSOURC times). The first card of this

Card Group consists of the principal parameters used to define the characteristics of a source. Cards 2 to 4 pertain to the gravitational settling categories of particulates (parameters PHI, VSN and GAMMA) and are read by the program only when parameter NVS in columns 8-9 of the first card is greater than "0" for a given source. If NVS is greater than "0", cards 2 to 4 are read immediately following the first source card for which NVS is greater than "0". It should be noted that cards 2 to 4 of this Card Group may actually consist of more than 3 cards. That is, if NVS is greater than "8", the program will read more than one card for each of the three settling category parameters (PHI, VSN and GAMMA). Hence, depending on the value of NVS, the program reads no cards, 3 cards, 6 cards or 9 cards for parameters PHI, VSN and GAMMA. After the first through fourth cards are read for all sources, card 5 (consisting of the source emission rate scalar array (QTK)) is read provided one of two options is exercised by the user. That is, either ISW(23) is greater than "0" in Card Group (2) or any number of the QFLG parameter in card 1 of this Card Group are greater than "0" for all input sources. If both ISW(23) and QFLG are equal to "0" for all sources, card 5 of this Card Group is not read by the program. If ISW(23) is greater than "0", card 5 is read once and contains the source emission rate scalars for all sources. Also, the QFLG parameter in card 1 of this Card Group is ignored for all input sources. If ISW(23) equals "0", card 5 is repeated each time a QFLG parameter is greater than "0" for a source. The source emission rate scalars contained in card 5 of this Card Group allow the user to vary emission rates as a function of season*, month*, hour of the day, wind speed and Pasquill stability category, or season and hour of the day. As mentioned in the descriptions of parameter QTK in Table 3-4 and Section 3.1.2.e, the value of ISW(23) or QFLG (whichever is applicable) governs the number and manner in which the source emission rate scalars are entered into parameter QTK. If ISW(23) (or QFLG) equals "1", QTK

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*The program determines the season or month based on the Julian Day or month value read from the hourly meteorological data. Consult Table 3-5 for the conversion used by the program of Julian Day to month or season, and month to season.

TABLE 3-5

JULIAN DAY TO MONTH/SEASON OR MONTH TO SEASON CONVERSION CHART FOR LEAP YEARS*

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Winter				Spring						Summer						Autumn						Winter	
Jan = 1		Feb = 2		Mar = 3		Apr = 4		May = 5		Jun = 6		Jul = 7		Aug = 8		Sep = 9		Oct = 10		Nov = 11		Dec = 12	
1	1	1	32	1	61	1	92	1	122	1	153	1	183	1	214	1	245	1	275	1	306	1	336
2	2	2	33	2	62	2	93	2	123	2	154	2	184	2	215	2	246	2	276	2	307	2	337
3	3	3	34	3	63	3	94	3	124	3	155	3	185	3	216	3	247	3	277	3	308	3	338
4	4	4	35	4	64	4	95	4	125	4	156	4	186	4	217	4	248	4	278	4	309	4	339
5	5	5	36	5	65	5	96	5	126	5	157	5	187	5	218	5	249	5	279	5	310	5	340
6	6	6	37	6	66	6	97	6	127	6	158	6	188	6	219	6	250	6	280	6	311	6	341
7	7	7	38	7	67	7	98	7	128	7	159	7	189	7	220	7	251	7	281	7	312	7	342
8	8	8	39	8	68	8	99	8	129	8	160	8	190	8	221	8	252	8	282	8	313	8	343
9	9	9	40	9	69	9	100	9	130	9	161	9	191	9	222	9	253	9	283	9	314	9	344
10	10	10	41	10	70	10	101	10	131	10	162	10	192	10	223	10	254	10	284	10	315	10	345
11	11	11	42	11	71	11	102	11	132	11	163	11	193	11	224	11	255	11	285	11	316	11	346
12	12	12	43	12	72	12	103	12	133	12	164	12	194	12	225	12	256	12	286	12	317	12	347
13	13	13	44	13	73	13	104	13	134	13	165	13	195	13	226	13	257	13	287	13	318	13	348
14	14	14	45	14	74	14	105	14	135	14	166	14	196	14	227	14	258	14	288	14	319	14	349
15	15	15	46	15	75	15	106	15	136	15	167	15	197	15	228	15	259	15	289	15	320	15	350
16	16	16	47	16	76	16	107	16	137	16	168	16	198	16	229	16	260	16	290	16	321	16	351
17	17	17	48	17	77	17	108	17	138	17	169	17	199	17	230	17	261	17	291	17	322	17	352
18	18	18	49	18	78	18	109	18	139	18	170	18	200	18	231	18	262	18	292	18	323	18	353
19	19	19	50	19	79	19	110	19	140	19	171	19	201	19	232	19	263	19	293	19	324	19	354
20	20	20	51	20	80	20	111	20	141	20	172	20	202	20	233	20	264	20	294	20	325	20	355
21	21	21	52	21	81	21	112	21	142	21	173	21	203	21	234	21	265	21	295	21	326	21	356
22	22	22	53	22	82	22	113	22	143	22	174	22	204	22	235	22	266	22	296	22	327	22	357
23	23	23	54	23	83	23	114	23	144	23	175	23	205	23	236	23	267	23	297	23	328	23	358
24	24	24	55	24	84	24	115	24	145	24	176	24	206	24	237	24	268	24	298	24	329	24	359
25	25	25	56	25	85	25	116	25	146	25	177	25	207	25	238	25	269	25	299	25	330	25	360
26	26	26	57	26	86	26	117	26	147	26	178	26	208	26	239	26	270	26	300	26	331	26	361
27	27	27	58	27	87	27	118	27	148	27	179	27	209	27	240	27	271	27	301	27	332	27	362
28	28	28	59	28	88	28	119	28	149	28	180	28	210	28	241	28	272	28	302	28	333	28	363
29	29	29	60	29	89	29	120	29	150	29	181	29	211	29	242	29	273	29	303	29	334	29	364
30	30			30	90	30	121	30	151	30	182	30	212	30	243	30	274	30	304	30	335	30	365
31	31			31	91			31	152			31	213	31	244			31	305			31	366

*For non-leap years, subtract 1 from Julian Day numbers corresponding to calendar days after February 28.

contains 4 seasonal scalars in the order of Winter, Spring, Summer and Fall (1 card). If ISW(23) (or QFLG) equals "2", enter 12 monthly scalars beginning with January and ending with December (2 cards). If ISW(23) (or QFLG) equals "3", enter 24 scalars for each hour of the day beginning with hour 1 and ending with hour 24 (3 cards). If ISW(23) (or QFLG) equals "4", enter 6 scalars per card for each wind speed category (1 to 6) and 6 cards for each of the six Pasquill stability categories (A to F) for a total of 36 scalars (6 cards). If ISW(23) (or QFLG) equals "5", enter 24 hourly scalars for each hour and 4 sets for each season (12 cards). Hence, card 5 of this Card Group may actually consist of more than one card depending on the value of ISW(23) (or QFLG).

Card Group (7) contains the hourly meteorological data parameters. This Card Group is not read if ISW(19) equals "1"; instead all hourly meteorological data are read from an input tape described in the following paragraph (Section 3.2.3.b). This Card Group is repeated for each day of meteorological data to be processed (NDAYS times). All meteorological data parameters are contained on one card image which is read for each hour per day of meteorological data (NHOURS times).

b. Tape Input Requirements. The ISCST program accepts an input tape file of hourly meteorological data in a format generated by the preprocessor program (see Appendix G). Although an input tape file is optional, most problem run cases call for hourly meteorological data contained in this format. If input parameter ISW(19) equals "1", the program reads hourly meteorology from an input tape file. If ISW(19) equals "2", the program reads hourly meteorological data in a card image format, requiring no input tape file. The program reads the input tape file from the FORTRAN logical unit number specified in parameter IMET. The user is required to assign the input meteorological tape and associate the same logical unit number as specified by IMET to the input tape (see Section 3.2.2.a). The user must also provide the surface station number and year, and the upper air station number and year which are specified in parameters ISS, ISY, IUS and IUY, respectively. The user does not need to know the specific format of the hourly meteorological data contained in the input tape file. For a description of the specific format of the input tape file, the reader is referred to Section G.5 of Appendix G.

3.2.4 Program Output Data Description

The ISCST program generates several categories of printed output and an optional output tape file. The following paragraphs describe the format and content of both forms of program output.

a. Printed Output. The ISCST program generates five categories of printed output, four of which are tables of average concentration or total deposition values. All five categories of printed output are optional to the user. That is, the user must indicate which categories are desired to be printed for a particular problem run. The five categories are:

- Input Data (Card and Tape) Listing
- Daily Calculated Average Concentration or Total Deposition Tables
- "N"-Day Calculated Average Concentration or Total Deposition Tables
- Highest and Second Highest Calculated Average Concentration or Total Deposition Tables
- Maximum 50 Calculated Average Concentration or Total Deposition Tables

The first line of each page of printed output is a heading used to identify the problem run (see input parameter TITLE in Section 3.2.3.a).

The user may list all input data parameters used by the program for a particular problem run. If input parameter ISW(6) equals "1" (discussed in Section 3.2.3.a), the program lists all program control parameters, meteorological-related constants and identification labels, receptor data and source data. Figure 3-2 is an illustration of the content and format of an input data listing for a typical problem run. The first page of the input data listing mostly consists of the program control parameter values, number of input sources and number of receptors. The second and third pages are a listing of meteorological-related constants such as the Julian Days to be processed by the program (printed only if ISW(19) equals "1"), wind speed categories, wind profile exponents and vertical potential temperature gradients. Also included are the locations of the receptor grid and discrete receptors. If receptor terrain elevations are input (ISW(4) equals "1"), a listing of the receptor elevations for all receptors is produced (not shown). The following page is a listing of source data parameters for all sources. Subsequent pages related to the input sources may be printed if NVS or QFLG are greater than zero. If NVS is greater than zero for an input source, a listing is produced of the mass fraction, settling velocity and surface reflection coefficient for each gravitational settling category. If QFLG is greater than zero for an input source, a listing is produced of the source scalars used to vary the source's emission rate. (Also, if ISW(23) is greater than zero, a listing is produced similar to the listing for QFLG greater than zero.)

Additionally, the user may also direct the program to print all hourly meteorology processed by the program. If ISW(6) equals "2", the program produces a list of the meteorological data for each day processed as shown in Figure 3-3. Hence, a page is generated for each day of meteorology processed by the program (NDAYS pages if ISW(19) equals "2" or the number of entries set to "1" in the IDAY array if ISW(19) equals "1").

The next category of optional printed output are tables of average concentration or total deposition values calculated for each day

```
                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION    - ***

CALCULATE (CONCENTRATION=1,DEPOSITION=2)                                  ISW(1) =    1
RECEPTOR GRID SYSTEM (RECTANGULAR=1 OR 3, POLAR=2 OR 4)                   ISW(2) =    1
DISCRETE RECEPTOR SYSTEM (RECTANGULAR=1,POLAR=2)                          ISW(3) =    2
TERRAIN ELEVATIONS ARE READ (YES=1,NO=0)                                  ISW(4) =    0
CALCULATIONS ARE WRITTEN TO TAPE (YES=1,NO=0)                             ISW(5) =    0
LIST ALL INPUT DATA (NO=0,YES=1,MET DATA ALSO=2)                          ISW(6) =    2

COMPUTE AVERAGE CONCENTRATION (OR TOTAL DEPOSITION)
WITH THE FOLLOWING TIME PERIODS:
  HOURLY (YES=1,NO=0)                                                     ISW(7) =    0
  2-HOUR (YES=1,NO=0)                                                     ISW(8) =    0
  3-HOUR (YES=1,NO=0)                                                     ISW(9) =    0
  4-HOUR (YES=1,NO=0)                                                    ISW(10) =    0
  6-HOUR (YES=1,NO=0)                                                    ISW(11) =    0
  8-HOUR (YES=1,NO=0)                                                    ISW(12) =    0
  12-HOUR (YES=1,NO=0)                                                   ISW(13) =    0
  24-HOUR (YES=1,NO=0)                                                   ISW(14) =    1
PRINT "N"-DAY TABLE(S) (YES=1,NO=0)                                      ISW(15) =    1

PRINT THE FOLLOWING TYPES OF TABLES WHOSE TIME PERIODS ARE
SPECIFIED BY ISW(7) THROUGH ISW(14):
  DAILY TABLES (YES=1,NO=0)                                              ISW(16) =    1
  HIGHEST & SECOND HIGHEST TABLES (YES=1,NO=0)                           ISW(17) =    1
  MAXIMUM 50 TABLES (YES=1,NO=0)                                         ISW(18) =    1
METEOROLOGICAL DATA INPUT METHOD (PRE-PROCESSED=1,CARD=2)                ISW(19) =    1
RURAL-URBAN OPTION (RURAL=0,URBAN MODE 1=1,URBAN MODE 2=2)               ISW(20) =    0
WIND PROFILE EXPONENT VALUES (DEFAULTS=1,USER ENTERS=2,3)                ISW(21) =    1
VERTICAL POT  TEMP  GRADIENT VALUES (DEFAULTS=1,USER ENTERS=2,3)         ISW(22) =    1
SCALE EMISSION RATES FOR ALL SOURCES (NO=0,YES>0)                        ISW(23) =    0
PROGRAM CALCULATES FINAL PLUME RISE ONLY (YES=1,NO=2)                    ISW(24) =    2
PROGRAM ADJUSTS ALL STACK HEIGHTS FOR DOWNWASH (YES=2,NO=1)              ISW(25) =    1

NUMBER OF INPUT SOURCES                                                   NSOURC =   16
NUMBER OF SOURCE GROUPS (=0,ALL SOURCES)                                  NGROUP =    5
TIME PERIOD INTERVAL TO BE PRINTED (=0,ALL INTERVALS)                      IPERD =    0
NUMBER OF X (RANGE) GRID VALUES                                           NXPNTS =   19
NUMBER OF Y (THETA) GRID VALUES                                           NYPNTS =   19
NUMBER OF DISCRETE RECEPTORS                                              NXWYPT =   64
SOURCE EMISSION RATE UNITS CONVERSION FACTOR                                  TK =   10000+07
ENTRAINMENT COEFFICIENT FOR UNSTABLE ATMOSPHERE                            BETA1 =   600
ENTRAINMENT COEFFICIENT FOR STABLE ATMOSPHERE                              BETA2 =   600
HEIGHT ABOVE GROUND AT WHICH WIND SPEED WAS MEASURED                          ZR =   10 00  METERS
LOGICAL UNIT NUMBER OF METEOROLOGICAL DATA                                  IMET =    9
DECAY COEFFICIENT FOR PHYSICAL OR CHEMICAL DEPLETION                       DECAY =    000000
SURFACE STATION NO                                                           ISS = 14913
YEAR OF SURFACE DATA                                                         ISY = 64
UPPER AIR STATION NO                                                         IUS = 14918
YEAR OF UPPER AIR DATA                                                       IUY = 64
ALLOCATED DATA STORAGE                                                     LIMIT = 43500 WORDS
REQUIRED DATA STORAGE FOR THIS PROBLEM RUN                                 MIMIT = 18211 WORDS
```

FIGURE 3-2.   Example input data listing (ISW(6) option).

```
                  *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                              *** METEOROLOGICAL DAYS TO BE PROCESSED ***
                                                (IF=1)

0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 1 0 0 0   0 0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 1 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0   0 1 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 1 0   0 0 0 0 0 0 0 0 1 0
0 0 0 0 1 0 0 0 0 0   0 1 0 0 0 0 0 0 0 0   0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0 1 0 0 0   0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0   0 0 0 0 0 0
                      *** NUMBER OF SOURCE NUMBERS REQUIRED TO DEFINE SOURCE GROUPS ***
                                                (NSOGRP)

   1.   2.   2.   1.   2.
                              *** SOURCE NUMBERS DEFINING SOURCE GROUPS ***
                                                (IDSOR)

    1.     2.   -11.    12.   -15.    16.     1.   -16.
                      *** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
                                              (METERS/SEC)

                                   1.54,   3.09,   5.14,   8.23,  10.80,

                                     *** WIND PROFILE EXPONENTS ***

   STABILITY
   CATEGORY                                   WIND SPEED CATEGORY
                     1              2              3              4              5              6
      A         .10000+00      .10000+00      .10000+00      .10000+00      .10000+00      .10000+00
      B         .15000+00      .15000+00      .15000+00      .15000+00      .15000+00      .15000+00
      C         .20000+00      .20000+00      .20000+00      .20000+00      .20000+00      .20000+00
      D         .25000+00      .25000+00      .25000+00      .25000+00      .25000+00      .25000+00
      E         .30000+00      .30000+00      .30000+00      .30000+00      .30000+00      .30000+00
      F         .30000+00      .30000+00      .30000+00      .30000+00      .30000+00      .30000+00
```

FIGURE 3-2. (Continued)

```
*** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***


                    *** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
                             (DEGREES KELVIN PER METER)

      STABILITY                         WIND SPEED CATEGORY
      CATEGORY         1             2             3             4             5             6
         A          .00000        .00000        .00000        .00000        .00000        .00000
         B          .00000        .00000        .00000        .00000        .00000        .00000
         C          .00000        .00000        .00000        .00000        .00000        .00000
         D          .00000        .00000        .00000        .00000        .00000        .00000
         E          .20000-01     .20000-01     .20000-01     .20000-01     .20000-01     .20000-01
         F          .35000-01     .35000-01     .35000-01     .35000-01     .35000-01     .35000-01

                    *** X-COORDINATES OF RECTANGULAR GRID SYSTEM ***
                                      (METERS)

  -3000.0,   -2000.0,   -1500.0,   -1250.0,   -1000.0,    -800.0,    -600.0,    -400.0,    -200.0,        0.
    200.0,     400.0,     600.0,     800.0,    1000.0,    1250.0,    1500.0,    2000.0,    3000.0,

                    *** Y-COORDINATES OF RECTANGULAR GRID SYSTEM ***
                                      (METERS)

  -3000.0,   -2000.0,   -1500.0,   -1250.0,   -1000.0,    -800.0,    -600.0,    -400.0,    -200.0,        0.
    200.0,     400.0,     600.0,     800.0,    1000.0,    1250.0,    1500.0,    2000.0,    3000.0,

                  *** RANGE,THETA COORDINATES OF DISCRETE RECEPTORS ***
                                  (METERS,DEGREES)

 (    555.0,    317.0), (    620.0,    318.0), (    685.0,    320.0), (    735.0,    322.0), (    800.0,    326.0),
 (    860.0,    331.0), (    900.0,    336.0), (    920.0,    341.0), (    940.0,    346.0), (    940.0,    351.0),
 (    935.0,    356.0), (    910.0,      1.0), (    950.0,      6.0), (   1015.0,     11.0), (   1055.0,     16.0),
 (   1075.0,     21.0), (   1075.0,     26.0), (   1045.0,     31.0), (    995.0,     36.0), (    910.0,     41.0),
 (    855.0,     43.0), (    755.0,     45.0), (    620.0,     47.0), (    525.0,     49.0), (    460.0,     51.0),
 (    355.0,     56.0), (    355.0,     66.0), (    355.0,     76.0), (    355.0,     86.0), (    350.0,     96.0),
 (    345.0,    106.0), (    335.0,    116.0), (    325.0,    126.0), (    380.0,    136.0), (    420.0,    141.0),
 (    450.0,    146.0), (    480.0,    151.0), (    505.0,    156.0), (    535.0,    161.0), (    575.0,    166.0),
 (    620.0,    171.0), (    665.0,    176.0), (    705.0,    181.0), (    730.0,    186.0), (    745.0,    191.0),
 (    755.0,    196.0), (    755.0,    201.0), (    745.0,    206.0), (    730.0,    211.0), (    705.0,    216.0),
 (    690.0,    221.0), (    690.0,    226.0), (    690.0,    231.0), (    680.0,    236.0), (    665.0,    241.0),
 (    645.0,    246.0), (    615.0,    251.0), (    575.0,    256.0), (    530.0,    261.0), (    475.0,    266.0),
 (    410.0,    271.0), (    365.0,    276.0), (    365.0,    286.0), (    410.0,    296.0), (
```

FIGURE 3-2. (Continued)

```
                         *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                                               *** SOURCE DATA ***

                          EMISSION RATE                                             TEMP.     EXIT VEL.
                            TYPE=0,1                                                TYPE=0     TYPE=0
              T W         (GRAMS/SEC)                                              (DEG.K)    (M/SEC)                BLDG.     BLDG.      BLDG.
              Y A NUMBER    TYPE=2                                   BASE           VERT.DIM  HORZ.DIM DIAMETER   HEIGHT    LENGTH      WIDTH
     SOURCE P K  PART.   (GRAMS/SEC)       X          Y          ELEV.    HEIGHT    TYPE=1   TYPE=1,2  TYPE=0     TYPE=0    TYPE=0     TYPE=0
     NUMBER E E  CATS.  *PER METER**2 (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

          1 2 0    6      .10000+00     -13.3      -13.3        .0     10.00       .00     26.60      .00       .00        .00        .00
          2 1 0    6      .13000+00      20.0         .0        .0       .90      1.00      4.70      .00       .00        .00        .00
          3 1 0    6      .13000+00      30.0         .0        .0      2.60      1.00      4.70      .00       .00        .00        .00
          4 1 0    6      .13000+00      40.0         .0        .0      4.30      1.00      4.70      .00       .00        .00        .00
          5 1 0    6      .13000+00      49.0         .0        .0      6.10      1.00      4.70      .00       .00        .00        .00
          6 1 0    6      .13000+00      59.0         .0        .0      7.80      1.00      4.70      .00       .00        .00        .00
          7 1 0    6      .13000+00      69.0         .0        .0      9.60      1.00      4.70      .00       .00        .00        .00
          8 1 0    6      .13000+00      79.0         .0        .0     11.30      1.00      4.70      .00       .00        .00        .00
          9 1 0    6      .13000+00      89.0         .0        .0     13.00      1.00      4.70      .00       .00        .00        .00
         10 1 0    6      .13000+00      99.0         .0        .0     14.80      1.00      4.70      .00       .00        .00        .00
         11 1 0    6      .13000+00     109.0         .0        .0     16.50      1.00      4.70      .00       .00        .00        .00
         12 1 0    0      .26300+01     121.0         .0        .0     22.50     11.60     10.80      .00       .00        .00        .00
         13 1 0    0      .26300+01     144.0         .0        .0     22.50     11.60     10.80      .00       .00        .00        .00
         14 1 0    0      .26300+01     167.0         .0        .0     22.50     11.60     10.80      .00       .00        .00        .00
         15 1 0    0      .26300+01     190.0         .0        .0     22.50     11.60     10.80      .00       .00        .00        .00
         16 0 0    0      .50000+01     201.0         .0        .0     50.00    340.00      8.00     1.00     25.00      90.00      50.00
```

FIGURE 3-2. (Continued)

```
*** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                    *** SOURCE PARTICULATE DATA ***

*** SOURCE NUMBER =      1 ***

MASS FRACTION =
  .10000,  .40000,  .28000,  .12000,  .06000,  .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,   .0070,   .0190,   .0370,   .0610,   .0990,

SURFACE REFLECTION COEFFICIENT =
 1.00000,  .82000,  .72000,  .65000,  .59000,  .50000,

*** SOURCE NUMBER =      2 ***

MASS FRACTION =
  .10000,  .40000,  .28000,  .12000,  .06000,  .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,   .0070,   .0190,   .0370,   .0610,   .0990,

SURFACE REFLECTION COEFFICIENT =
 1.00000,  .82000,  .72000,  .65000,  .59000,  .50000,

*** SOURCE NUMBER =      3 ***

MASS FRACTION =
  .10000,  .40000,  .28000,  .12000,  .06000,  .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,   .0070,   .0190,   .0370,   .0610,   .0990,

SURFACE REFLECTION COEFFICIENT =
 1.00000,  .82000,  .72000,  .65000,  .59000,  .50000,
```

FIGURE 3-2. (Continued)

```
*** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                    *** SOURCE PARTICULATE DATA ***

*** SOURCE NUMBER =      4 ***

MASS FRACTION =
 .10000, .40000, .28000, .12000, .06000, .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,  .0070,  .0190,  .0370,  .0610,  .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000, .82000, .72000, .65000, .59000, .50000,

*** SOURCE NUMBER =      5 ***

MASS FRACTION =
 .10000, .40000, .28000, .12000, .06000, .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,  .0070,  .0190,  .0370,  .0610,  .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000, .82000, .72000, .65000, .59000, .50000,

*** SOURCE NUMBER =      6 ***

MASS FRACTION =
 .10000, .40000, .28000, .12000, .06000, .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,  .0070,  .0190,  .0370,  .0610,  .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000, .82000, .72000, .65000, .59000, .50000,
```

FIGURE 3-2. (Continued)

```
                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                                   *** SOURCE PARTICULATE DATA ***

*** SOURCE NUMBER =      7 ***

MASS FRACTION =
 .10000,  .40000,  .28000,  .12000,  .06000,  .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,   .0070,   .0190,   .0370,   .0610,   .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000,  .82000,  .72000,  .65000,  .59000,  .50000,

*** SOURCE NUMBER =      8 ***

MASS FRACTION =
 .10000,  .40000,  .28000,  .12000,  .06000,  .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,   .0070,   .0190,   .0370,   .0610,   .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000,  .82000,  .72000,  .65000,  .59000,  .50000,

*** SOURCE NUMBER =      9 ***

MASS FRACTION =
 .10000,  .40000,  .28000,  .12000,  .06000,  .04000,

SETTLING VELOCITY(METERS/SEC) =
   .0010,   .0070,   .0190,   .0370,   .0610,   .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000,  .82000,  .72000,  .65000,  .59000,  .50000,
```

FIGURE 3-2. (Continued)

```
*** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                    *** SOURCE PARTICULATE DATA ***

*** SOURCE NUMBER =     10 ***

MASS FRACTION =
 .10000, .40000, .28000, .12000, .06000, .04000,

SETTLING VELOCITY(METERS/SEC) =
  .0010,  .0070,  .0190,  .0370,  .0610,  .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000, .82000, .72000, .65000, .59000, .50000,

*** SOURCE NUMBER =     11 ***

MASS FRACTION =
 .10000, .40000, .28000, .12000, .06000, .04000,

SETTLING VELOCITY(METERS/SEC) =
  .0010,  .0070,  .0190,  .0370,  .0610,  .0990,

SURFACE REFLECTION COEFFICIENT =
1.00000, .82000, .72000, .65000, .59000, .50000,
```

FIGURE 3-2. (Continued)

```
                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                    * SOURCE EMISSION RATE SCALARS WHICH VARY FOR EACH HOUR OF THE DAY *

     HOUR    SCALAR      HOUR    SCALAR      HOUR    SCALAR      HOUR    SCALAR      HOUR    SCALAR      HOUR    SCALAR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE NO. =      1
        1    .10000+01      2    .10000+01      3    .10000+01      4    .10000+01      5    .10000+01      6    .10000+01
        7    .10000+01      8    .50000+01      9    .50000+01     10    .50000+01     11    .50000+01     12    .50000+01
       13    .50000+01     14    .50000+01     15    .50000+01     16    .10000+01     17    .10000+01     18    .10000+01
       19    .10000+01     20    .10000+01     21    .10000+01     22    .10000+01     23    .10000+01     24    .10000+01
```

FIGURE 3-2. (Continued)

```
                                                                                          MET. DATA
              *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***        DAY  51

                         * METEOROLOGICAL DATA FOR DAY  51 *

                       RANDOM
              FLOW      FLOW       WIND      MIXING                 INPUT       ADJUSTED
             VECTOR    VECTOR      SPEED     HEIGHT      TEMP.    STABILITY    STABILITY
   HOUR    (DEGREES) (DEGREES)     (MPS)    (METERS)   (DEG. K)    CATEGORY     CATEGORY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     1       160.0     158.0       5.14      761.2      261.5         4             4
     2       160.0     163.0       3.60      764.2      260.4         5             5
     3       150.0     154.0       3.60      767.2      259.8         5             5
     4       150.0     151.0       4.63      770.2      258.7         5             5
     5       150.0     148.0       5.66      773.1      258.1         4             4
     6       140.0     143.0       6.17      776.1      257.6         4             4
     7       150.0     152.0       6.17      779.1      257.0         4             4
     8       150.0     155.0       5.66      782.1      257.0         4             4
     9       160.0     162.0       4.63      785.1      256.5         3             3
    10       160.0     157.0       5.14      788.1      258.7         4             4
    11       170.0     173.0       5.14      791.0      260.9         4             4
    12       160.0     162.0       6.17      794.0      262.6         4             4
    13       150.0     148.0       4.63      797.0      263.7         3             3
    14       160.0     160.0       6.69      800.0      264.8         4             4
    15       150.0     154.0       6.17      800.0      264.8         4             4
    16       130.0     146.0       6.69      800.0      265.4         4             4
    17       160.0     138.0       6.17      800.0      264.8         4             4
    18       160.0     157.0       4.12      802.9      263.1         5             5
    19       160.0     165.0       3.60      809.5      262.0         5             5
    20       160.0     161.0       4.63      816.1      260.9         5             5
    21       160.0     165.0       5.14      822.7      259.8         5             5
    22       160.0     156.0       3.60      829.3      259.3         5             5
    23       150.0     146.0       4.12      835.9      258.7         5             5
    24       160.0     160.0       5.66      842.5      258.1         4             4
```

FIGURE 3-3. Example listing of a day of meteorological data (ISW(6) option).

("daily") of meteorology processed by the program. If ISW(16) equals "1", tables are printed for each day for all user-defined combinations of source groups and time periods. As shown in Figure 3-4, each table consists of the calculated average concentration or total deposition values for all receptors. Although the concentration or deposition values in the output tables include five decimal places in order to show low values arising from low emissions or low values relative to the highest values, the results of the model calculations should not be considered to be accurate to five or more significant figures. The calculated concentration or deposition values are printed first for the receptor grid (if any). The heading of the table indicates the day, time period, time period interval* and sources that represent the printed values. The heading information is also listed in a cryptic format in the upper right-hand corner of the page. The maximum average concentration or total deposition value found among the table of receptor grid values is printed. Next, the calculated values for the discrete receptors (if any) are printed beginning on a new page with a heading similar to that printed for the receptor grid.

The user may direct the program to print tables of calculated concentration averaged over "N"-days or deposition summed over "N"-days where "N" represents the total number of days of meteorology processed by the program run. If ISW(15) equals "1", tables are printed for all user-defined source groups. As shown in Figure 3-5, each table consists of the calculated concentration or deposition values for all receptors. The calculated values are first printed for the receptor grid (if any). The heading of the table indicates the number of days over which the table is produced ("N") and which sources contributed to the calculated values. The heading information is listed in a cryptic format in the upper right-hand corner of the page. The maximum value found for the receptor grid is printed. Beginning on a new page, the calculated

---

*See Table 3-6 for the hours which define a particular time period interval.

TABLE 3-6

TIME PERIOD INTERVALS AND CORRESPONDING HOURS OF THE DAY

Time Period Interval Number	Time Period							
	1-Hour	2-Hour	3-Hour	4-Hour	6-Hour	8-Hour	12-Hour	24-Hour
1	0-1	0-2	0-3	0-4	0-6	0-8	0-12	0-24
2	1-2	2-4	3-6	4-8	6-12	9-16	12-24	–
3	2-3	4-6	6-9	8-12	12-18	16-24	–	
4	3-4	6-8	9-12	12-16	18-24	–	–	–
5	4-5	8-10	12-15	16-20	–	–	–	–
6	5-6	10-12	15-18	20-24	–	–	–	–
7	6-7	12-14	18-21	–	–	–	–	–
8	7-8	14-16	21-24	–	–	–	–	–
9	8-9	16-18	–	–	–	–	–	–
10	9-10	18-20	–	–	–	–	–	–
11	10-11	20-22	–	–	–	–	–	–
12	11-12	22-24	–	–	–	–	–	–
13	12-13	–	–	–	–	–	–	–
14	13-14	–	–	–	–	–	–	–
15	14-15	–	–	–	–	–	–	–
16	15-16	–	–	–	–	–	–	–
17	16-17	–	–	–	–	–	–	–
18	17-18	–	–	–	–	–	–	–
19	18-19	–	–	–	–	–	–	–
20	19-20	–	–	–	–	–	–	–
21	20-21	–	–	–	–	–	–	–
22	21-22	–	–	–	–	–	–	–
23	22-23	–	–	–	–	–	–	–
24	23-24	–	–	–	–	–	–	–

```
                                                                                              DAILY:  51
                                                                                              24-HR/PD 1
                   *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***      SGROUP#  3

                   * DAILY 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                              * ENDING WITH HOUR 24 FOR DAY  51 *
                               * FROM SOURCES:      12,    -15,
                                  * FOR THE RECEPTOR GRID *

                * MAXIMUM VALUE EQUALS    205.91974 AND OCCURRED AT (     200.0,    -200.0) *
 Y-AXIS   /                                             X-AXIS (METERS)
(METERS)  /     -3000.0    -2000.0    -1500.0    -1250.0    -1000.0     -800.0     -600.0     -400.0     -200.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 3000.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 2000.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 1500.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 1250.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 1000.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
  800.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
  600.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
  400.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
  200.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
      0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 -200.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 -400.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 -600.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
 -800.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
-1000.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
-1250.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000
-1500.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00001
-2000.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00016
-3000.0  /       .00000     .00000     .00000     .00000     .00000     .00000     .00000     .00001     .00133
```

FIGURE 3-4. Example listing of a "daily" average concentration output table (ISW(16) option). Note that the results in the concentration or deposition output tables are in fixed point rather than scientific notation for user convenience. No claim of model accuracy to five decimal places is made for this or any concentration or deposition output table.

```
                                                                                            DAILY:  51
                                                                                            24-HR/PD 1
                                                                                            SGROUP# 3

                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                    * DAILY 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                               * ENDING WITH HOUR 24 FOR DAY  51 *
                              * FROM SOURCES:        12,   -15,
                                   * FOR THE RECEPTOR GRID *

                 * MAXIMUM VALUE EQUALS    205.91974 AND OCCURRED AT (      200.0,    -200.0) *

                                                         X-AXIS (METERS)
 Y-AXIS   /
 (METERS) /          .0        200.0       400.0       600.0       800.0      1000.0      1250.0      1500.0      2000.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  3000.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
  2000.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
  1500.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
  1250.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
  1000.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
   800.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
   600.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
   400.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
   200.0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
      .0 /         .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
  -200.0 /         .00000   205.91974     4.73236      .00008      .00000      .00000      .00000      .00000      .00000
  -400.0 /         .00016    39.61426   125.83667     1.86694      .00174      .00000      .00000      .00000      .00000
  -600.0 /         .00207    12.47965   143.40306    39.36984     1.03534      .00552      .00001      .00000      .00000
  -800.0 /         .00719     6.62089    89.20368    71.92775    15.99408      .65719      .00321      .00002      .00000
 -1000.0 /         .01426     4.20003    46.58354    81.25763    35.18431     7.47949      .19736      .00201      .00000
 -1250.0 /         .02333     2.66060    18.46155    60.00740    49.16711    22.64871     3.46626      .15321      .00007
 -1500.0 /         .03083     1.81599     8.23092    40.99999    49.97206    29.62188    12.84532     1.87138      .00433
 -2000.0 /         .03957      .97937     3.31048    13.90630    30.64077    34.20554    21.43504    12.10795      .73466
 -3000.0 /         .04127      .40632     1.34338     2.12759     6.60176    15.35725    18.09126    19.29385     8.21911
```

FIGURE 3-4. (Continued)

```
                                                                                               DAILY:  51
                                                                                               24-HR/PD 1
                                                                                               SGROUP# 3
                        *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                        * DAILY 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                   * ENDING WITH HOUR 24 FOR DAY  51 *
                                    * FROM SOURCES:        12.   -15.
                                      * FOR THE RECEPTOR GRID *

                      * MAXIMUM VALUE EQUALS    205.91974 AND OCCURRED AT (     200.0,    -200.0) *
                                                   X-AXIS (METERS)
   Y-AXIS   /                                                                                   
  (METERS)  /      3000.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   3000.0 /      .00000
   2000.0 /      .00000
   1500.0 /      .00000
   1250.0 /      .00000
   1000.0 /      .00000
    800.0 /      .00000
    600.0 /      .00000
    400.0 /      .00000
    200.0 /      .00000
       .0 /      .00000
   -200.0 /      .00000
   -400.0 /      .00000
   -600.0 /      .00000
   -800.0 /      .00000
  -1000.0 /      .00000
  -1250.0 /      .00000
  -1500.0 /      .00000
  -2000.0 /      .00002
  -3000.0 /      .21505
```

FIGURE 3-4. (Continued)

```
                                                                                        DAILY:  51
                                                                                        24-HR/PD 1
              *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***      SGROUP0  3

               * DAILY 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                               * ENDING WITH HOUR 24 FOR DAY  51 *
                                 * FROM SOURCES:       12.   -15.
                               * FOR THE DISCRETE RECEPTOR POINTS *
  - RNG -    - DIR -     CON.       - RNG -    - DIR -     CON.       - RNG -    - DIR -     CON.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   555.0      317.0      .00000      620.0      318.0      .00000      685.0      320.0      .00000
   735.0      322.0      .00000      800.0      326.0      .00000      860.0      331.0      .00000
   900.0      336.0      .00000      920.0      341.0      .00000      940.0      346.0      .00000
   940.0      351.0      .00000      935.0      356.0      .00000      910.0        1.0      .00000
   950.0        6.0      .00000     1015.0       11.0      .00000     1055.0       16.0      .00000
  1075.0       21.0      .00000     1075.0       26.0      .00000     1045.0       31.0      .00000
   995.0       36.0      .00000      910.0       41.0      .00000      855.0       43.0      .00000
   755.0       45.0      .00000      620.0       47.0      .00000      525.0       49.0      .00000
   460.0       51.0      .00000      355.0       56.0      .00000      355.0       66.0      .00000
   355.0       76.0      .00000      355.0       86.0      .00000      350.0       96.0      .00006
   345.0      106.0      .74947      335.0      116.0    61.66626      325.0      126.0   270.49908
   380.0      136.0   261.61783      420.0      141.0   215.76877      450.0      146.0   146.44760
   480.0      151.0    77.02658      505.0      156.0    29.76986      535.0      161.0    10.57386
   575.0      166.0     3.52426      620.0      171.0      .71228      665.0      176.0      .06247
   705.0      181.0      .00185      730.0      186.0      .00001      745.0      191.0      .00000
   755.0      196.0      .00000      755.0      201.0      .00000      745.0      206.0      .00000
   730.0      211.0      .00000      705.0      216.0      .00000      690.0      221.0      .00000
   690.0      226.0      .00000      690.0      231.0      .00000      680.0      236.0      .00000
   665.0      241.0      .00000      645.0      246.0      .00000      615.0      251.0      .00000
   575.0      256.0      .00000      530.0      261.0      .00000      475.0      266.0      .00000
   410.0      271.0      .00000      365.0      276.0      .00000      365.0      286.0      .00000
   410.0      296.0      .00000
```

FIGURE 3-4. (Continued)

```
                                                                                                  "N"-DAY
                                                                                                   10 DAYS
                        *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***   SGROUP#  2

                           *  10-DAY AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *

                                          * FROM SOURCES:        2.    -11.
                                            * FOR THE RECEPTOR GRID *

                     * MAXIMUM VALUE EQUALS      19.55864 AND OCCURRED AT (      200.0,      200.0) *

    Y-AXIS    /                                                   X-AXIS (METERS)
   (METERS)   /      -3000.0      -2000.0      -1500.0      -1250.0      -1000.0      -800.0      -600.0      -400.0      -200.0
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    3000.0 /         .00379       .13594       .08312       .01310       .00069      .00004      .00000      .00000      .00000
    2000.0 /         .50355       .01042       .08744       .30058       .18698      .02593      .00087      .00001      .00000
    1500.0 /         .42209       .51490       .02203       .02690       .35072      .42864      .06255      .00008      .00000
    1250.0 /         .50142      1.18515       .27417       .03600       .06412      .53477      .39810      .01316      .00003
    1000.0 /         .65580       .81570      1.60911       .60328       .06706      .08507      .85516      .22028      .00065
     800.0 /         .65771      1.06125      1.54827      2.44303      1.11891      .12821      .24350     1.11938      .01404
     600.0 /         .72732      1.25936      1.69907      1.72136      3.67227     2.93072      .36923      .90824      .40827
     400.0 /         .61007      1.39884      1.98263      2.63202      3.26572     3.56341     7.26782     1.16263     3.12628
     200.0 /         .28045       .77120      1.80568      2.88136      4.13897     5.34441     8.15958    11.19211     8.97102
        .0 /         .20279       .39000       .61642       .82080      1.15974     1.65148     2.62001     4.85777    12.49825
    -200.0 /         .12277       .15415       .14332       .11660       .07122      .03092      .00546      .00012      .00000
    -400.0 /         .04033       .01506       .00294       .00058       .00004      .00000      .00000      .00000      .00000
    -600.0 /         .00604       .00028       .00001       .00000       .00000      .00000      .00000      .00000      .00174
    -800.0 /         .00039       .00000       .00000       .00000       .00000      .00000      .00000      .00000      .01884
   -1000.0 /         .00001       .00000       .00000       .00000       .00000      .00000      .00000      .00005      .05645
   -1250.0 /         .00000       .00000       .00000       .00000       .00000      .00000      .00000      .00115      .11626
   -1500.0 /         .00000       .00000       .00000       .00000       .00000      .00000      .00002      .00648      .17534
   -2000.0 /         .00000       .00000       .00000       .00000       .00000      .00001      .00154      .03177      .25791
   -3000.0 /         .00000       .00000       .00000       .00000       .00023      .00355      .02272      .08682      .27111
```

FIGURE 3-5. Example listing of an "N"-day average concentration output table (ISW(15) option).

```
                                                                                                  "N"-DAY
                                                                                                  10 DAYS
                                                                                                 SGROUP#  2
                          *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                          *  10-DAY AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *

                                          * FROM SOURCES:        2,    -11,
                                           * FOR THE RECEPTOR GRID *

                   * MAXIMUM VALUE EQUALS      19.55864 AND OCCURRED AT (      200.0,      200.0) *

 Y-AXIS   /                                               X-AXIS (METERS)
(METERS)  /          .0        200.0        400.0        600.0        800.0       1000.0       1250.0       1500.0       2000.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  3000.0 /      .00021       .00917       .08483       .29060       .31158       .14985       .21665       .24463       .19389
  2000.0 /      .00040       .04783       .50843       .50412       .33497       .47071       .37844       .45311       .71405
  1500.0 /      .00060       .17286       .95553       .50400       .71484       .60200      1.07729      1.15517       .68717
  1250.0 /      .00076       .40580      1.03341       .95639       .82038      1.17887      1.57224      1.93075       .78791
  1000.0 /      .00099      1.02864       .98524      1.25437      1.60237      2.29016      2.31409      1.22928       .45536
   800.0 /      .00128      2.06478      1.84034      1.80974      3.30140      3.54549      1.69871      1.05281       .37186
   600.0 /      .00176      3.37712      2.81676      5.20137      4.28234      2.52872      1.03737       .62806       .15742
   400.0 /      .00402      4.96265      9.15645      5.85779      2.73591      1.30902       .39109       .57876       .30468
   200.0 /      .71724     19.55864      9.47573      1.96576      1.81070      1.21092       .76032       .67270       .26480
      .0 /      .00000      2.23411       .89796       .50499       .32276       .22445       .15854       .11880       .07492
  -200.0 /     4.88986      6.00057      6.53752      2.32495       .64024       .18242       .04340       .01265       .00350
  -400.0 /     4.07129      9.94799      1.29573      2.17407      2.55880      1.27223       .48513       .21711       .04122
  -600.0 /     3.17418      6.50573      2.32979       .55008      1.66965      1.06957      1.35741       .57672       .17509
  -800.0 /     2.47149      4.40760      3.16556       .82503       .31914      1.06126       .52405       .82813       .33462
 -1000.0 /     1.95317      3.36499      2.45173      1.14723       .42571       .21629       .78602       .30004       .62977
 -1250.0 /     1.50975      2.22100      2.02463      1.61413       .56476       .27515       .14752       .47657       .31534
 -1500.0 /     1.19636      1.43846      1.39329      1.18727       .84438       .35568       .15793       .10812       .32429
 -2000.0 /      .80511       .71417      1.09354       .97663       .72593       .64182       .24998       .15264       .06628
 -3000.0 /      .44829       .33716       .57389       .52389       .46296       .45793       .39972       .30418       .10650
```

FIGURE 3-5. (Continued)

```
                                                                                                   *H*-DAY
                                                                                                    10 DAYS
                                                                                                   SGROUP#  2
                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                      *  10-DAY AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *

                                      * FROM SOURCES:        2,   -11,
                                        * FOR THE RECEPTOR GRID *

                 * MAXIMUM VALUE EQUALS     19.55864 AND OCCURRED AT (     200.0,     200.0) *

  Y-AXIS   /                                    X-AXIS (METERS)
 (METERS)  /        3000.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   3000.0 /         .36482
   2000.0 /         .39912
   1500.0 /         .21502
   1250.0 /         .19483
   1000.0 /         .08015
    800.0 /         .19504
    600.0 /         .13382
    400.0 /         .21862
    200.0 /         .05774
       .0 /         .03962
   -200.0 /         .00487
   -400.0 /         .00221
   -600.0 /         .01790
   -800.0 /         .05999
  -1000.0 /         .10807
  -1250.0 /         .18160
  -1500.0 /         .33362
  -2000.0 /         .09057
  -3000.0 /         .03319
```

FIGURE 3-5.   (Continued)

```
                                                                                        "H"-DAY
                                                                                        10 DAYS
                     *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***   SGROUP#  2

                     *   10-DAY AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *

                                         * FROM SOURCES:        2,   -11,
                                      * FOR THE DISCRETE RECEPTOR POINTS *

  - RNG -     - DIR -     CON.              - RNG -     - DIR -     CON.              - RNG -     - DIR -     CON.
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    555.0       317.0       .64430            620.0       310.0       .32151            685.0       320.0       .17095
    735.0       322.0       .32230            800.0       326.0       .76855            860.0       331.0      1.36164
    900.0       336.0       .70925            920.0       341.0       .11470            940.0       346.0       .00646
    940.0       351.0       .00022            935.0       356.0       .00001            910.0         1.0       .00291
    950.0         6.0       .10125           1015.0        11.0       .94628           1055.0        16.0      1.71317
   1075.0        21.0      1.01459           1075.0        26.0      1.38512           1045.0        31.0      1.50867
    995.0        36.0      1.71214            910.0        41.0      3.52849            855.0        43.0      4.66738
    755.0        45.0      6.19663            620.0        47.0      9.21869            525.0        49.0     13.27804
    460.0        51.0     17.12016            355.0        56.0     20.77974            355.0        66.0     10.67538
    355.0        76.0      4.82090            355.0        86.0      2.93978            350.0        96.0       .45671
    345.0       106.0      5.86115            335.0       116.0      9.52768            325.0       126.0      6.57453
    380.0       136.0      3.38442            420.0       141.0      4.46995            450.0       146.0      6.35272
    480.0       151.0      8.18763            505.0       156.0      8.51923            535.0       161.0      8.48276
    575.0       166.0      7.71552            620.0       171.0      5.87146            665.0       176.0      4.33245
    705.0       181.0      2.33030            730.0       186.0       .59311            745.0       191.0       .08491
    755.0       196.0       .00687            755.0       201.0       .00018            745.0       206.0       .00000
    730.0       211.0       .00000            705.0       216.0       .00000            690.0       221.0       .00000
    690.0       226.0       .00000            690.0       231.0       .00000            680.0       236.0       .00000
    665.0       241.0       .00000            645.0       246.0       .00009            615.0       251.0       .00423
    575.0       256.0       .08683            530.0       261.0       .67749            475.0       266.0      2.36500
    410.0       271.0      5.16094            365.0       276.0     11.20536            365.0       286.0     10.16617
    410.0       296.0     12.96254
```

FIGURE 3-5. (Continued)

values for the discrete receptors (if any) are printed with a heading similar to that printed for the receptor grid.

The program may also print tables of the highest and second highest average concentration or total deposition values calculated at each receptor point throughout the duration of the problem run. If ISW(17) equals "1", a table of the highest and a table of the second highest calculated values are printed for all user-defined combinations of source groups and time periods. Figure 3-6 is an illustration of a highest calculated average concentration or total deposition table. The second highest table is not shown but is similar in format. The calculated values are first printed for the receptor grid points (if any). The heading indicates the time period and sources which represent the calculated values. The heading information is listed in a cryptic format in the upper right-hand corner of the page. The maximum value found among the receptor grid values for a given table is printed. The calculated values for the discrete receptors (if any) are then printed beginning on a new page. Beside each calculated value for all receptors, the day and the time period interval* are enclosed in parentheses and indicate when the corresponding highest (or second highest) calculated value occurred.

The final category of printed output that may be produced are tables of the maximum 50 calculated average concentration or total deposition values found for the problem run. If ISW(18) equals "1", a table of the 50 maximum values is produced for all user-defined combinations of source groups and time periods. As shown in Figure 3-7, each table consists of a heading and the maximum 50 calculated values. The heading specifies the time period and sources that represent the maximum 50 values. The heading information is also listed in a cryptic format in the upper right-hand corner of the page. For each of the maximum 50 calculated values, the order (rank), the calculated value itself, the

---

*See Table 3-6 for the hours which define a particular time period interval.

```
                                                                                                   HIGH
                                                                                                   24-HR
                                                                                                   SGROUP#  1
                         *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                         * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                            * FROM SOURCES:         1,
                                               * FOR THE RECEPTOR GRID *

                      * MAXIMUM VALUE EQUALS  29257.33984 AND OCCURRED AT (          .0,    -200.0) *

 Y-AXIS   /                                             X-AXIS (METERS)
(METERS)  /          -3000.0              -2000.0              -1500.0              -1250.0              -1000.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   3000.0 /       7.01088 (187, 1)    78.74459 (305, 1)    18.80492 (305, 1)     2.66758 (205, 1)      .22506 (187, 1)
   2000.0 /     262.92981 (187, 1)    16.39869 (187, 1)    73.82420 (305, 1)   153.63390 (305, 1)    38.32646 (305, 1)
   1500.0 /     286.99170 (305, 1)   240.66960 (187, 1)    29.79066 (187, 1)    31.76500 (187, 1)   236.79732 (305, 1)
   1250.0 /     326.64682 (305, 1)   455.56999 (187, 1)   134.89873 (187, 1)    43.37550 (187, 1)    70.12573 (305, 1)
   1000.0 /     373.36642 (305, 1)   564.73594 (305, 1)   802.14337 (187, 1)   283.60898 (187, 1)    68.49780 (187, 1)
    800.0 /     393.97098 (262, 1)   675.95557 (305, 1)  1070.54025 (205, 1)  1044.73756 (187, 1)   425.15841 (187, 1)
    600.0 /     385.86480 (262, 1)   618.58744 (305, 1)  1082.33798 (305, 1)  1233.12947 (305, 1)  1861.97388 (205, 1)
    400.0 /     269.97475 (262, 1)   746.60553 (262, 1)  1190.02315 (262, 1)  1454.61662 (305, 1)  2083.11252 (305, 1)
    200.0 /     225.80037 (262, 1)   468.32584 (262, 1)   861.27760 (262, 1)  1330.66579 (262, 1)  2264.69687 (262, 1)
       .0 /     247.35113 (262, 1)   477.78599 (262, 1)   759.00874 (262, 1)  1015.25744 (262, 1)  1444.61826 (262, 1)
   -200.0 /     194.09293 (262, 1)   244.51450 (262, 1)   209.60483 (262, 1)   149.95262 (262, 1)    67.56431 (262, 1)
   -400.0 /      61.45128 (262, 1)    16.28438 (262, 1)     1.66652 (262, 1)      .15093 (262, 1)      .00295 (187, 1)
   -600.0 /       6.82030 (262, 1)      .12364 (262, 1)      .00073 (187, 1)      .00003 (187, 1)      .00000 (187, 1)
   -800.0 /        .26891 (262, 1)      .00026 (187, 1)      .00000 (187, 1)      .00000 (187, 1)      .00000 (187, 1)
  -1000.0 /        .00396 (262, 1)      .00000 (187, 1)      .00000 (187, 1)      .00000 (187, 1)      .00000 (337, 1)
  -1250.0 /        .00002 (187, 1)      .00000 (187, 1)      .00000 (187, 1)      .00000 (337, 1)      .00000 (337, 1)
  -1500.0 /        .00000 (187, 1)      .00000 (187, 1)      .00000 (337, 1)      .00000 (337, 1)      .00000 (337, 1)
  -2000.0 /        .00000 (187, 1)      .00000 (337, 1)      .00000 (337, 1)      .00000 (337, 1)      .00021 (337, 1)
  -3000.0 /        .00000 (337, 1)      .00000 (337, 1)      .00005 (337, 1)      .01587 (337, 1)     1.52175 (337, 1)
```

FIGURE 3-6. Example listing of a highest average concentration output table (ISW(17) option).

```
                                                                                                    HIGH
                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***            24-HR
                                                                                                    SGROUP#  1

                    * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                          * FROM SOURCES:        1,
                                            * FOR THE RECEPTOR GRID *

                  * MAXIMUM VALUE EQUALS  29257.33984 AND OCCURRED AT (        .0,    -200.0) *

 Y-AXIS   /
(METERS)  /                                              X-AXIS (METERS)
                   -800.0                -600.0                -400.0                -200.0                  .0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  3000.0 /       .02187 (187, 1)        .00103 (187, 1)        .00002 (187, 1)        .00140 (289, 1)        .39458 (289, 1)
  2000.0 /      3.64513 (205, 1)        .23969 (187, 1)        .00440 (187, 1)        .00018 (289, 1)       1.03276 (289, 1)
  1500.0 /    118.39290 (305, 1)       6.56493 (205, 1)        .17455 (187, 1)        .00037 (187, 1)       2.02372 (289, 1)
  1250.0 /    329.68170 (305, 1)      53.75400 (205, 1)       1.50348 (187, 1)        .00314 (187, 1)       3.07055 (289, 1)
  1000.0 /    103.86832 (305, 1)     427.40199 (305, 1)      15.05959 (187, 1)        .04380 (187, 1)       5.07164 (289, 1)
   800.0 /    107.80066 (187, 1)     331.47763 (305, 1)     188.70668 (305, 1)        .57678 (187, 1)       8.50962 (289, 1)
   600.0 /   1164.95976 (187, 1)     192.61037 (187, 1)     999.93413 (305, 1)      12.40346 (187, 1)      16.37711 (289, 1)
   400.0 /   2586.00357 (305, 1)    3429.66122 (187, 1)     431.43685 (187, 1)     596.57519 (305, 1)      40.20404 (289, 1)
   200.0 /   3417.10876 (262, 1)    5034.82111 (305, 1)    8261.22119 (305, 1)    1618.61168 (187, 1)     159.62988 (289, 1)
      .0 /   2113.19528 (262, 1)    3410.68469 (262, 1)    6411.06494 (262, 1)   14624.32703 (262, 1)        .00000 (  0, 0)
  -200.0 /     16.72914 (262, 1)        .65443 (262, 1)        .00080 (187, 1)        .00000 (337, 1)   29257.33984 (337, 1)
  -400.0 /       .00006 (187, 1)        .00000 (187, 1)        .00000 (337, 1)        .08076 (337, 1)   12556.48901 (337, 1)
  -600.0 /        00000 (187, 1)        .00000 (337, 1)        .00000 (337, 1)      41.96467 (337, 1)    6761.63867 (337, 1)
  -800.0 /       .00000 (337, 1)        .00000 (337, 1)        .00620 (337, 1)     250.86494 (337, 1)    4217.97260 (337, 1)
 -1000.0 /        00000 (337, 1)        .00000 (337, 1)        .71882 (337, 1)     442.10267 (337, 1)    2898.65292 (337, 1)
 -1250.0 /        00000 (337, 1)         00420 (337, 1)      13.46043 (337, 1)     557.08878 (337, 1)    2017.04434 (337, 1)
 -1500.0 /        00006 (337, 1)        .24976 (337, 1)      54.82798 (337, 1)     589.01745 (337, 1)    1501.84814 (337, 1)
 -2000.0 /       .12187 (337, 1)      12.00114 (337, 1)     160.56051 (337, 1)     549.62419 (337, 1)     949.64354 (337, 1)
 -3000.0 /     20.03640 (337, 1)      98.79222 (337, 1)     227.32941 (337, 1)     396.21886 (337, 1)     513.20028 (337, 1)
```

FIGURE 3-6. (Continued)

```
                                                                                                            HIGH
                                                                                                            24-HR
                                                                                                            SGROUP#  1
                              *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                              * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                              * FROM SOURCES:          1,
                                                   * FOR THE RECEPTOR GRID *

                         * MAXIMUM VALUE EQUALS  29257.33984 AND OCCURRED AT (           .0,     -200.0) *

   Y-AXIS   /                                                     X-AXIS (METERS)
  (METERS)  /              200.0                   400.0                   600.0                   800.0                   1000.0
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     3000.0 /       12.09791 (289,  1)      95.99378 (289,  1)     208.16702 (289,  1)     210.70117 (289,  1)     123.79415 (289,  1)
     2000.0 /       72.26086 (289,  1)     408.23549 (289,  1)     279.99178 (289,  1)     395.55615 (289,  1)     586.41706 (289,  1)
     1500.0 /      309.13699 (289,  1)     640.51051 (289,  1)     631.27656 (289,  1)     900.32335 (289,  1)     579.07925 (312,  1)
     1250.0 /      692.94864 (289,  1)     535.10152 (289,  1)    1212.21214 (289,  1)     760.05359 (289,  1)    1535.92755 (312,  1)
     1000.0 /     1264.42076 (289,  1)    1213.19186 (289,  1)    1356.18518 (289,  1)    2180.26080 (312,  1)    1233.37479 (312,  1)
      800.0 /     1062.76083 (289,  1)    2495.05020 (289,  1)    2630.63773 (312,  1)    1791.38394 (312,  1)    1324.06496 (299,  1)
      600.0 /     1880.63634 (289,  1)    2670.74228 (312,  1)    2905.20343 (312,  1)    1902.53619 (299,  1)    1912.80093 (299,  1)
      400.0 /     7380.99609 (289,  1)    5631.48242 (312,  1)    3601.52902 (299,  1)    1782.01617 (299,  1)     754.60027 (299,  1)
      200.0 /    13594.94873 (312,  1)    5105.16809 (299,  1)     534.33291 (299,  1)    1363.01515 (312,  1)     392.20446 (312,  1)
          0 /      728.76321 (229,  1)     491.65845 (229,  1)     293.93680 (229,  1)     192.29752 (229,  1)     135.66249 (229,  1)
     -200.0 /     3096.53659 (229,  1)    7997.71472 (229,  1)    2584.90671 (229,  1)     833.65382 (229,  1)     250.04896 (229,  1)
     -400.0 /     7299.68079 ( 51,  1)    1015.86070 (229,  1)    1761.94778 (229,  1)    2744.46030 (229,  1)    1336.52791 (229,  1)
     -600.0 /     4195.57330 ( 51,  1)    1210.95793 ( 51,  1)     491.51054 (229,  1)     925.43362 (229,  1)    1236.53349 (229,  1)
     -800.0 /     1835.72150 (337,  1)    2395.10950 ( 51,  1)     399.74553 ( 51,  1)     292.65735 (229,  1)     883.61901 (229,  1)
    -1000.0 /     1727.78735 (337,  1)    2078.45715 ( 51,  1)     773.98990 ( 51,  1)     162.50557 ( 51,  1)     196.84149 (229,  1)
    -1250.0 /     2039.88640 (337,  1)    1196.73647 ( 51,  1)    1293.01970 ( 51,  1)     406.83203 ( 51,  1)     109.67669 ( 51,  1)
    -1500.0 /     1821.19019 (337,  1)     654.31646 (337,  1)    1084.91153 ( 51,  1)     675.81919 ( 51,  1)     256.72969 ( 51,  1)
    -2000.0 /     1091.00719 (337,  1)     524.65175 (337,  1)     507.92515 ( 51,  1)     680.26542 ( 51,  1)     539.92422 ( 51,  1)
    -3000.0 /      479.52023 (337,  1)     611.11151 (337,  1)     265.07733 (337,  1)     212.32002 (337,  1)     300.43372 ( 51,  1)
```

FIGURE 3-6. (Continued)

```
                                                                                           HIGH
                                                                                           24-HR
                    *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***   SGROUP#  1

                  * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                    * FROM SOURCES:        1,
                                       * FOR THE RECEPTOR GRID *

                * MAXIMUM VALUE EQUALS  29257.33984 AND OCCURRED AT (         .0,    -200.0) *
 Y-AXIS   /
(METERS)  /                                                    X-AXIS (METERS)
                     1250.0                 1500.0                 2000.0                 3000.0
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  3000.0 /      232.93274 (289,  1)     308.86749 (289,  1)     183.11969 (312,  1)     198.61736 (299,  1)
  2000.0 /      388.30664 (289,  1)     613.38634 (312,  1)     380.83041 (299,  1)     260.78502 (299,  1)
  1500.0 /     1157.59996 (312,  1)     617.68366 (312,  1)     418.99287 (299,  1)     197.32846 (299,  1)
  1250.0 /      843.64531 (312,  1)     749.72033 (299,  1)     594.75001 (299,  1)     131.88338 (299,  1)
  1000.0 /      918.70258 (299,  1)     816.41238 (299,  1)     390.22298 (299,  1)      34.40998 (299,  1)
   800.0 /     1198.75235 (299,  1)     732.87447 (299,  1)     240.38709 (299,  1)     138.52283 (312,  1)
   600.0 /      842.67531 (299,  1)     389.74961 (299,  1)     103.29487 (312,  1)      50.33080 (312,  1)
   400.0 /       98.41490 (312,  1)     449.64553 (312,  1)     108.72939 (312,  1)     135.59004 (299,  1)
   200.0 /      476.74028 (299,  1)     414.32555 (299,  1)     122.60080 (299,  1)      26.02315 (229,  1)
       0 /       96.84216 (229,  1)      73.09407 (229,  1)      46.51416 (229,  1)      24.81405 (229,  1)
  -200.0 /       62.48043 (229,  1)      18.66026 (229,  1)       3.62507 (229,  1)       3.00988 (229,  1)
  -400.0 /      694.99847 (229,  1)     346.06254 (229,  1)      72.33568 (229,  1)       4.20383 (229,  1)
  -600.0 /     1295.53807 (229,  1)     673.32644 (229,  1)     284.09501 (229,  1)      34.60614 (229,  1)
  -800.0 /      659.75797 (229,  1)     901.26665 (229,  1)     412.39845 (229,  1)     108.52377 (229,  1)
 -1000.0 /      611.78599 (229,  1)     353.98938 (229,  1)     624.02987 (229,  1)     170.60395 (229,  1)
 -1250.0 /      131.95607 (229,  1)     439.53657 (229,  1)     336.35190 (229,  1)     218.67608 (229,  1)
 -1500.0 /       52.19541 ( 51,  1)      95.09326 (229,  1)     176.88272 (229,  1)     323.26402 (229,  1)
 -2000.0 /      199.56817 ( 51,  1)      84.66453 ( 51,  1)      56.71505 (229,  1)     103.10881 (229,  1)
 -3000.0 /      359.34361 ( 51,  1)     279.02787 ( 51,  1)      80.32958 ( 51,  1)      27.30454 (229,  1)
```

FIGURE 3-6. (Continued)

```
                                                                                                   HIGH
                                                                                                   24-HR
                                                                                                   SGROUP# 1
                        *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

                     * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                          * FROM SOURCES:          1,
                                       * FOR THE DISCRETE RECEPTOR POINTS *

    - RNG -      - DIR -      CON.     (DAY,PER.)              - RNG -      - DIR -      CON.     (DAY,PER.)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     555.0        317.0    363.35759  (187,  1)                 620.0        318.0    281.45566  (187,  1)
     685.0        320.0    242.87609  (187,  1)                 735.0        322.0    367.98349  (305,  1)
     800.0        326.0    833.51421  (305,  1)                 860.0        331.0    478.96017  (305,  1)
     900.0        336.0     61.94616  (205,  1)                 920.0        341.0      6.68790  (187,  1)
     940.0        346.0       .39082  (187,  1)                 940.0        351.0       .00820  (187,  1)
     935.0        356.0       .04938  (289,  1)                 910.0          1.0     15.25862  (289,  1)
     950.0          6.0    310.12568  (289,  1)                1015.0         11.0   1252.37616  (289,  1)
    1055.0         16.0    984.78966  (289,  1)                1075.0         21.0   1064.22385  (289,  1)
    1075.0         26.0   1028.96118  (289,  1)                1045.0         31.0   1605.53326  (289,  1)
     995.0         36.0   2312.04056  (312,  1)                 910.0         41.0   3716.50061  (312,  1)
     855.0         43.0   3334.30417  (312,  1)                 755.0         45.0   3532.88397  (312,  1)
     620.0         47.0   5498.56348  (299,  1)                 525.0         49.0   6816.95062  (299,  1)
     460.0         51.0   7187.11414  (299,  1)                 355.0         56.0   9529.39441  (299,  1)
     355.0         66.0   4968.47260  (299,  1)                 355.0         76.0   3324.30042  (312,  1)
     355.0         86.0    668.70051  (299,  1)                 350.0         96.0    288.95413  (229,  1)
     345.0        106.0   5091.62152  (229,  1)                 335.0        116.0  11717.47192  (229,  1)
     325.0        126.0   5328.33734  (229,  1)                 380.0        136.0   1627.61234  (229,  1)
     420.0        141.0   1051.16229  ( 51,  1)                 450.0        146.0   2513.70938  ( 51,  1)
     480.0        151.0   4777.69012  ( 51,  1)                 505.0        156.0   7180.53339  ( 51,  1)
     535.0        161.0   5699.72949  ( 51,  1)                 575.0        166.0   3225.32541  (337,  1)
     620.0        171.0   6371.78607  (337,  1)                 665.0        176.0   5821.85095  (337,  1)
     705.0        181.0   5090.61237  (337,  1)                 730.0        186.0   2722.19998  (337,  1)
     745.0        191.0    846.50612  (337,  1)                 755.0        196.0    119.60140  (337,  1)
     755.0        201.0      3.92454  (337,  1)                 745.0        206.0       .02435  (337,  1)
     730.0        211.0       .00004  (337,  1)                 705.0        216.0       .00000  (337,  1)
     690.0        221.0       .00000  (337,  1)                 690.0        226.0       .00000  (187,  1)
     690.0        231.0       .00000  (187,  1)                 680.0        236.0       .00000  (187,  1)
     665.0        241.0       .00001  (187,  1)                 645.0        246.0       .00244  (187,  1)
     615.0        251.0       .39407  (262,  1)                 575.0        256.0     40.88502  (262,  1)
     530.0        261.0    797.13342  (262,  1)                 475.0        266.0   3713.44977  (262,  1)
     410.0        271.0   6243.87268  (262,  1)                 365.0        276.0   8224.08228  (262,  1)
     365.0        286.0  10781.29871  (262,  1)                 410.0        296.0   9458.34009  (305,  1)
```

FIGURE 3-6. (Continued)

```
                                                                                              MAX 50
                                                                                              24-HR
                              *** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***        SGROUP# 3

                        * 50 MAXIMUM 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *

                                           * FROM SOURCES:       12.   -15.

                                     X      Y(METERS)                                          X      Y(METERS)
                                     OR        OR                                              OR        OR
                                   RANGE   DIRECTION                                         RANGE   DIRECTION
   RANK       CON.      PER. DAY  (METERS) (DEGREES)        RANK       CON.      PER. DAY  (METERS) (DEGREES)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     1     365.60716     1   229     345.0     106.0          26     174.78666     1   312     600.0     400.0
     2     357.13231     1   337     200.0    -200.0          27     170.18014     1   305    -200.0     200.0
     3     306.66805     1   312     355.0      66.0          28     160.01897     1   312     460.0      51.0
     4     281.32770     1   299     355.0      66.0          29     151.16765     1   229     400.0    -200.0
     5     274.64339     1   337     200.0    -400.0          30     149.43143     1   262    -200.0        .0
     6     270.49908     1    51     325.0     126.0          31     146.44760     1    51     450.0     146.0
     7     261.61783     1    51     380.0     136.0          32     145.61457     1   337     420.0     141.0
     8     243.53223     1   337     505.0     156.0          33     143.40306     1    51     400.0    -600.0
     9     238.94873     1   299     400.0     200.0          34     138.19619     1   312     525.0      49.0
    10     231.92527     1   205    -200.0     200.0          35     134.27904     1   229     335.0     116.0
    11     230.57580     1   337     480.0     151.0          36     133.93348     1   299     600.0     400.0
    12     227.51217     1   312     400.0     200.0          37     133.60077     1   337     200.0    -800.0
    13     223.18893     1   299     355.0      76.0          38     130.02702     1   312     800.0     600.0
    14     221.24822     1   337     535.0     161.0          39     129.24978     1   187     365.0     286.0
    15     215.76877     1    51     420.0     141.0          40     129.15974     1   289     460.0      51.0
    16     214.17474     1   262        .0        .0          41     128.57054     1   299     800.0     400.0
    17     213.90416     1   312     355.0      56.0          42     128.26113     1   187     410.0     296.0
    18     205.91974     1    51     200.0    -200.0          43     126.49464     1   262    -600.0     200.0
    19     193.78723     1   262     365.0     286.0          44     125.83667     1    51     400.0    -400.0
    20     192.98119     1   337     450.0     146.0          45     124.67772     1   262     410.0     296.0
    21     189.49826     1   337     200.0    -600.0          46     123.24991     1   262     365.0     276.0
    22     184.51424     1   289     200.0     200.0          47     122.15517     1   289     400.0     400.0
    23     182.02673     1   229     600.0    -200.0          48     120.45045     1   305     410.0     296.0
    24     176.59334     1   289     355.0      56.0          49     118.68963     1   205    -600.0     400.0
    25     176.15851     1   337     575.0     166.0          50     117.97248     1   187    -200.0     200.0
```

FIGURE 3-7. Example listing of a maximum 50 average concentrations output table (ISW(18) option).

time period interval*, the day and the receptor location are listed. This information allows the user to identify when and where the calculated value occurred.

In general, the order in which the printed output is listed corresponds to the order that the five categories of print output have been mentioned in the preceding paragraphs. First, all input data parameters, excluding the hourly meteorological data, are optionally listed if ISW(6) equals "1". Tables of the average concentration or total deposition calculated for each time-period/source-group combination for each day ("daily") of meteorological data processed are then listed. Also printed for each day, if ISW(6) equals "2", are the hourly meteorology for that day. The number of tables of daily average concentration or total deposition values is governed by the number of source groups (specified in parameter NGROUP), time periods (specified in parameters ISW(7) through ISW(14)) and time period intervals (parameter IPERD). The order in which the daily tables of average concentration or total deposition are produced is best described by an example. Suppose we have five source groups, desire average concentrations for 1-, 3-, 12- and 24-hour time periods, and all time period intervals are to be printed. For a given day, the following set of tables are produced: (1) for Hour one, 5 tables of 1-hour averages for source groups 1 through 5 are printed; (2) for Hour two, 5 tables of 1-hour averages are printed for the 5 source groups; (3) for Hour three, a 1-hour average table followed by a 3-hour average table are printed for source group 1. Similarly, 1-hour and 3-hour average tables are alternately printed for the second through fifth source groups; (4) for Hour four, 5 tables of 1-hour averages for source groups 1 through 5 are printed; (5) for Hour five, the same format is printed as that for Hours one, two and four; (6) for Hour six, the same format is printed as that for Hour three. This format is continued for each hour of the day. For Hour twelve, 1-hour, 3-hour and 12-hour tables are printed for each of the five source groups. For Hour twenty four, 1-hour, 3-hour, 12-hour and 24-hour tables are printed for each of the five source groups. This format is repeated for each day of meteorological data. Hence, if ISW(6) equals "2" and ISW(16) equals "1", a listing of the meteorological data and a set of daily tables would be alternately printed for each day of meteorological data processed by the program. After all hourly meteorological data have been processed by the program, the "N"-day tables, highest and second highest tables and the maximum 50 tables are alternately printed for each source group for each specified time interval. The number of tables is governed by the number of source groups (NGROUP) and time periods (ISW(7) through ISW(14)) specified. For each source group, the "N"-day, highest and second highest and the maximum 50 tables are listed in this order:

---

*See Table 3-6 for the hours which define a particular time period interval.

For source group 1:
  Print "N"-day table (only if ISW(15) = 1)
  For the 1-hour time period (only if ISW(7) = 1):
    Print highest and second highest tables (only if ISW(17) = 1)
    Print maximum 50 table (only if ISW(18) = 1)
  For the 2-hour time period (only if ISW(8) = 1):
    Print highest and second highest tables (only if ISW(17) = 1)
    Print maximum 50 table (only if ISW(18) = 1)
  For the 3-hour time period (only if ISW(9) = 1):
    Print highest and second highest tables (only if ISW(17) = 1)
    Print maximum 50 table (only if ISW(18) = 1)

.   .   .
.   .   .
.   .   .

  For the 24-hour time period (only if ISW(14) = 1)
    Print highest and second highest tables (only if ISW(17) = 1)
    Print maximum 50 table (only if ISW(18) = 1)

The order and number of tables printed according to the above format is repeated for all source groups.

b. Tape Output. The ISCST program is capable of generating an output tape file containing the calculated average concentration or total deposition values based on the selected time periods and source groups. If ISW(5) equals "1", this output tape file is generated. The user must assign an output file and associate the logical unit number specified in parameter ITAP to the output file (see Section 3.2.2.a). The output file is written with a FORTRAN unformatted (binary) WRITE statement and consists of constant length records whose lengths equal the total number of receptor points (NPNTS) plus 3 words. Words 4 through NPNTS + 3 contain the calculated average concentration or total deposition values for all receptors. The values calculated for the receptor grid (if any) are written first followed by the values calculated at the discrete receptors (if any). Starting with the first Y point (direction radial) of the Y-axis (radial) grid, the calculated values are written for the X-axis (ranges) in the same order that receptor locations were entered in parameter GRIDX (see Section 3.2.3.a). For each successive Y-axis (radial), the values are written for the X-axis (ranges). After the calculated values have been written for the receptor grid, the calculated values are written for the discrete points in the order the discrete points were entered in parameters XDIS and YDIS (see Section 3.2.3.a). Word 1 of each record contains the hour at which the corresponding values were calculated in words 4 to NPNTS + 3. Word 2 contains the Julian Day and word 3 contains the source group number. The content and number of records produced is governed by the number of source groups (specified in parameter NGROUP) and time periods (specified in parameters ISW(7) through ISW(14)). For each day of meteorological data processed by the program and for each hour, the program generates records of calculated values for all applicable time period intervals for all source groups. For Hour one, a 1-hour record of calculated values for source group 1, followed by a 1-hour record of calculated values for source group 2, up to a 1-hour record of calculated values for the last source group are written to the output file. For Hour two, a 1-hour and a 2-hour record are written to the output file for each source group. For Hour three, a 1-hour and 3-hour record are written to the output file for each source group. For Hour four, a 1-hour, 2-hour and 4-hour record of calculated values are written to the output file for each source group. This format is continued for each hour of the day. The applicable time period interval records that are written depend on parameters ISW(7) through ISW(14). For example, if there is one source group and only 24-hour average concentrations are calculated in a problem run, only one record per day of meteorological data processed is written to the output file. If ISW(15) equals "1", records of the "N"-day average concentration or total deposition values are additionally written to the output file for all source groups after the program has processed all "N" days of meteorological data. At the conclusion of the problem run, two end-of-file marks are written at the end of the output tape file.

3.2.5 Program Run Time, Page and Tape Output Estimates

This section provies the user with equations which estimate the amount of run time required and program output generated for a given problem run. The equations describing the amount of printed output data (in pages) and tape output data (in words) can be quite accurately estimated. The run time estimate is less accurate because of unknowns such as the nature of the hourly meteorology and wake effects. These unknowns may affect the run time estimate by several minutes for a large problem run.

a. Run Time. The amount of time a problem takes to execute is primarily governed by six factors. These factors are: (1) the number of hours in a day of meteorological data (NHOURS); (2) the number of days of meteorological data processed (NDAYS); (3) the number of sources (NSOURC); (4) the number of source groups (NGROUP); (5) the number of receptor points (NPNTS); and (6) the number of time periods (NAVG). Using these factors, the following equation estimates the run time in minutes:

$$\text{No. of Minutes} = C \cdot (\text{NDAYS} + 1) \cdot \Big(1 + \text{NHOURS} \cdot \big(1 + 0.8 \cdot \text{NSOURC} \cdot (1 + 0.6 \cdot \text{NPNTS} + 0.1 \cdot \text{NGROUP} \cdot \text{NAVG})\big)\Big) \qquad (3\text{-}2)$$

where

$$C = 2.1 \cdot 10^{-5}$$

The constant, C, is derived from problem runs made on a UNIVAC 1108 computer and is different for other computer models.

b. Page Output. The number of pages of printer output produced by a problem run is primarily controlled by which categories of output are desired by the user. The content of these categories of program print output are discussed in Section 3.2.4.a. Input parameters ISW(6), ISW(15), ISW(16), ISW(17) and ISW(18), discussed in Section 3.2.3.a, control which categories of program print output are produced. Other factors which determine the amount of print output are the number of receptor points, number of source groups and the number of time periods for which average concentration or total deposition values are computed.

If ISW(6) equals "1", all input data are printed, producing about 5 pages of print output. For sources with gravitational settling categories (NVS greater than zero) or variational emission rates (QFLG greater than zero), add one third of a page per source. If ISW(6) equals "2", all meteorological data processed by the program are printed. Add one page for every day of meteorological data processed.

If ISW(15) equals "1", tables of the "N"-day average concentration or total deposition values are printed. The number of tables printed equals the number of source groups desired by the user (NGROUP). If parameter NGROUP is specified as "0", one table will be printed. The number of pages produced for each "N"-day table is given by the following equation:

$$\text{Number of Pages} = \left(\frac{\text{NXPNTS}}{9}\right) \cdot \left(\frac{\text{NYPNTS}}{38}\right) + \left(\frac{\text{NXWYPT}}{114}\right) \qquad (3\text{-}3)$$

where

NXPNTS = the number of X points on the X-axis grid or the number of grid ranges

NYPNTS = the number of Y points on the Y-axis grid or the number of grid direction radials

NXWYPT = the number of discrete receptor points

Round up any fractional number in each term to the nearest whole number.

If ISW(16) equals "1", tables of average concentration or total deposition for user-defined combinations of source groups and time periods for each day of meteorological data processed by the program are printed. The number of tables produced by this output category for each day is given by the following equation:

$$\begin{aligned}\text{No. of Tables} = \text{NGROUP} \cdot \Big[& (24/\text{IPERD}) \cdot \text{ISW}(7) \\ & + (12/\text{IPERD}) \cdot \text{ISW}(8) + (8/\text{IPERD}) \cdot \text{ISW}(9) \\ & + (6/\text{IPERD}) \cdot \text{ISW}(10) + (4/\text{IPERD}) \cdot \text{ISW}(11) \\ & + (3/\text{IPERD}) \cdot \text{ISW}(12) + (2/\text{IPERD}) \cdot \text{ISW}(13) \\ & + (1/\text{IPERD}) \cdot \text{ISW}(14) \Big]\end{aligned} \qquad (3\text{-}4)$$

where

NGROUP = number of source groups as specified by input parameter NGROUP. If NGROUP is specified as "0", assume a value of "1" for this equation

IPERD = "N"th time interval for all time periods as specified by input parameter IPERD. Note that if IPERD is set to "0", the term (j/IPERD) • ISW(i) equals (j) • ISW(i). If IPERD is set greater than "0", the term (j/IPERD) • ISW(i) equals (1) • ISW(i) if (j/IPERD) is greater than or equal to "1"; otherwise, it equals (0) • ISW(i) if (j/IPERD) is less than "1".

ISW(7)-
ISW(14) = the corresponding 1-, 2-, 3-, 4-, 6-, 8-, 12- and 24-hour time periods as specified by input parameters ISW(7) through ISW(14). The "1" or "0" values specified by the user in these parameters are the numeric values used in the equation

The number of pages produced by each table is given in Equation (3-3). Hence, the total number of pages generated by this print output option (ISW(16)) equals the product of the number of days processed by the program for a problem run, the number of tables printed according to Equation (3-4) and the number of pages produced per table according to Equation (3-3).

If ISW(17) equals "1", tables of the highest and second highest average concentration or total deposition values found at each receptor are printed for all user-defined combinations of source groups and time periods. The number of tables printed equals twice the number of time periods specified (the number of input parameters ISW(7) through ISW(14) set to "1") multiplied by the number of source groups desired. If no source groups are specified (input parameter NGROUP equals "0"), assume one source group for the purpose of computing the number of tables printed by this option (ISW(17)). The number of pages each table produces is given by the following equation:

$$\text{No. of Pages} = \left(\frac{\text{NXPNTS}}{5}\right) \cdot \left(\frac{\text{NYPNTS}}{38}\right) + \left(\frac{\text{NXWYPT}}{76}\right) \qquad (3\text{-}5)$$

where NXPNTS, NYPNTS and NXWYPT are defined following Equation (3-3). Round up any fractional number in each term to the nearest whole number. Hence, the number of pages printed by this output category equals two times the product of the number of time periods, the number of source groups and the number of pages produced per table according to Equation (3-5).

If ISW(18) equals "1", tables of the maximum 50 average concentration or total deposition values calculated are printed for all user-defined combinations of source groups and time periods. Because each table printed produces only one page of output, the total number of pages printed by this output category equals the number of time periods specified (the number of input parameters (ISW(7) through ISW(14) set to "1") multiplied by the number of source groups specified. Again, if no source groups are specified (input parameter NGROUP equal to zero), assume one source group.

Thus, the total number of pages of output produced by the program equals the sum of the number of pages produced by each optional print output category desired by the user for a problem run.

c. Tape Output. Values of average concentration or total deposition are written by a FORTRAN unformatted WRITE statement to an output tape file only if parameter ISW(5) equals "1". Otherwise, the program does not generate an output tape file. It is not practical to discuss the physical amount (length of magnetic tape or number of tracks or sectors of mass storage) generated since this introduces factors which depend on the computer installation. Instead, the number of computer words generated by a problem run is discussed. The user may then equate this number to a physical amount for the particular storage device being used.

The output tape is written in records, where the length of each record equals the number of receptor points (NPNTS) plus 3 for a total of NPNTS + 3 computer words for a given problem run. For each day of meteorological data processed, the number of records written to the output tape file is governed by the number of source groups and time periods specified by the user. If we substitute the term "Tables" used in Equation (3-4) with the word, "Records" and set IPERD equal to "0", Equation (3-4) gives the number of records written to the output tape file for each day of meteorological data processed. All variables used to formulate Equation (3-4) maintain the same definition. Hence, the number of records equals the value computed from Equation (3-4) multiplied by the number of days of meteorological data processed by the program for a problem run. Also, if input parameter ISW(15) equals "1", additional records containing "N"-day average concentration or total deposition values are written to the output tape file depending on the number of source groups specified by input parameter NGROUP (If NGROUP equals "0", assume one source group). Hence, the total number of computer words written to the output tape file equals the number of records generated, multiplied by (NPNTS + 3) computer words per record for a problem run.

3.2.6 Program Diagnostic Messages

The ISCST program prints diagnostic messages when certain conditions occur during a problem run. The diagnostic messages consist of two types. The first type is a table format that informs the user of the conditions found, but does not terminate program execution. The second type is an error message which informs the user of the condition. The run is terminated after the error message is printed.

The diagnostic message in a table format informs the user when a receptor is located within 100 meters or three building heights (or three effective building widths) of a source. As shown in Figure 3-8, the table lists all source-receptor combinations for which this condition has occurred. The table lists the source number, receptor location and calculated distance between the corresponding source and receptor. A negative distance value implies that the receptor is located within the dimensions of a volume or area source.

Five types of diagnostic error messages may be printed by the program. If the allocated data storage is not sufficient for the data required by a problem run, an error message is printed (Figure 3-9(a)). An error message is printed if the station numbers or years read from

```
*** --  HYPOTHETICAL POTASH PROCESSING PLANT - CONCENTRATION  -- ***

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 100 METERS OR THREE BUILDING
  HEIGHTS IN DISTANCE.  NO AVERAGE CONCENTRATION    IS CALCULATED *

                  - - RECEPTOR LOCATION - -
                       X          Y (METERS)          DISTANCE
SOURCE             GR RANGE    OR DIRECTION           BETWEEN
NUMBER             (METERS)     (DEGREES)             (METERS)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   1                     .0           .0              -15.01
   2                     .0           .0                9.90
   3                     .0           .0               19.90
   4                     .0           .0               29.90
   5                     .0           .0               38.90
   6                     .0           .0               48.90
   7                     .0           .0               58.90
   8                     .0           .0               68.90
   9                     .0           .0               78.90
  10                     .0           .0               88.90
  10                  200.0           .0               90.90
  11                     .0           .0               98.90
  11                  200.0           .0               80.90
  12                     .0           .0               97.78
  12                  200.0           .0               55.78
  13                  200.0           .0               32.78
  14                  200.0           .0                9.78
  15                  200.0           .0              -13.22
  16                  200.0           .0                1.00
```

FIGURE 3-8. Example listing of a diagnostic message table printed when source-receptor distances are less than the maximum of 100 meters and three building heights or three building widths.

```
***ERROR*** CALCULATED STORAGE ALLOCATION LIMIT EQUALS nnnnnn
AND EXCEEDS THE MAXIMUM STORAGE ALLOCATION LIMIT OF mmmmmm
RUN TERMINATED.

                                 (a)


***ERROR*** MET DATA REQUESTED DOES NOT MATCH MET DATA READ.
'REQUESTED/READ' VALUES ARE:
SURFACE STATION NO. = isisis/jsjsjs YEAR OF SURFACE DATA = iys/jys
UPPER AIR STATION NO. = iuiuiu/jujuju YEAR OF UPPER AIR DATA = iuy/juy
RUN TERMINATED.

                                 (b)


***ERROR*** NUMBER OF SOURCES TO BE READ EQUALS ZERO.  RUN TERMINATED.

                                 (c)


***ERROR*** PHYSICAL STACK HEIGHT OF SOURCE nnnnn
IS LOWER THAN THE TERRAIN ELEVATION FOR THE RECEPTOR
LOCATED AT (xxxxxxx.x,yyyyyyy.y).  RUN TERMINATED.

                                 (d)


***ERROR*** SOURCE NUMBER nnnnn HAS NO GRAVITATIONAL SETTLING CATEGORIES
WITH WHICH TO CALCULATE DEPOSITION.  RUN TERMINATED.

                                 (e)
```

FIGURE 3-9. (a) through (e) show the five types of error messages printed by the ISCST Program. The run is terminated after an error message is printed.

the meteorological data input tape do not match the corresponding station numbers or years specified by the user in parameters ISS, ISY, IUS, IUY (Figure 3-9(b)). If the number of input sources equals "0", an error message is printed (Figure 3-9(c)). If the physical stack height of any source is lower in elevation than the terrain elevation of any receptor, an error message is printed (Figure 3-9(d)). Finally, if there are no gravitational settling categories to calculate deposition for any source, an error message is printed as shown in Figure 3-9(e).

3.2.7 Program Modification for Computers Other than UNIVAC 1100 Series Computers

The ISCST program, which is written in FORTRAN IV, provides easy transport and adaptation for use on other computer models. The program design requires that: (1) At least four Hollerith characters can be stored in one computer word; (2) The computer word lengths of integer and real type variables are the same; and, (3) At least 132 characters per line can be printed on a page with 57 lines per page. The program requires about 65,000 words of executable storage, 21,500 of which consist of the program itself compiled on a UNIVAC 1108 Computer. The size of the compiled program will vary depending on the FORTRAN IV compiler and computer installation. The remaining 43,500 words consist of data storage used by the program for storing the input data values, intermediate values and output results of a given problem run.

If it is necessary to adjust the current allotment of 43,500 words of data storage, only two FORTRAN statements in the ISCST program need to be modified. Line 601 (see page A-17) in Appendix A) of the main program allocates the data storage in array QF. Also, the value assigned to the variable LIMIT in line 609 must agree with the value used in array QF.

The program assumes FORTRAN logical unit 5 for the card reader and logical unit 6 for the printer. These logical unit numbers may be modified on lines 616 and 617 in the main section of the program.

SECTION 4

USER'S INSTRUCTIONS FOR THE ISC LONG-TERM (ISCLT) MODEL PROGRAM

4.1 SUMMARY OF PROGRAM OPTIONS, DATA REQUIREMENTS AND OUTPUT

4.1.1 Summary of ISCLT Program Options

The program options of the ISC Dispersion Model long-term computer program ISCLT consist of three general categories:

- Meteorological data input options
- Dispersion-model options
- Output options

Each category is discussed separately below.

a. Meteorological Data Input Options. Table 4-1 lists the meteorological data input options for the ISCLT computer program. All meteorological data may be input by card deck or by a magnetic tape inventory previously generated by ISCLT (see Section 4.1.1.c below). ISCLT accepts STAR summaries with six Pasquill stability categories (A through F) or five Pasquill stability categories (A through E with the E and F categories combined). Site-specific mixing heights and ambient air temperatures are ISCLT input requirements rather than options. Suggested procedures for developing these inputs are given in Section 2.2.1.2. The remaining meteorological data input options listed in Table 4-1 are identical to the ISCST meteorological data input options discussed in Section 3.1.1.a.

b. Dispersion Model Options. Table 4-2 lists the dispersion model options for the ISCLT computer program. In general, these options correspond to the ISCST dispersion-model options discussed

TABLE 4-1

METEOROLOGICAL DATA INPUT OPTIONS FOR ISCLT

Input of all meteorological data by card deck or by magnetic tape inventory previously generated by ISCLT
STAR summaries with five or six Pasquill stability categories
Site-specific mixing heights
Site-specific ambient air temperatures
Site-specific wind-profile exponents
Site-specific vertical potential temperature gradients
Rural Mode or Urban Mode 1 or 2
Entrainment coefficients other than the Briggs (1975) coefficients
Final or distance dependent plume rise
Wind system measurement height other than 10 meters

TABLE 4-2

DISPERSION-MODEL OPTIONS FOR ISCLT

Concentration or dry deposition calculations
Inclusion of the effects of gravitational settling and/or dry deposition in concentration calculations
Inclusion of terrain effects (concentration calculations only)
Cartesian or polar receptor system
Discrete receptors (Cartesian or polar system)
Stack, volume and area sources
Pollutant emission rates held constant or varied by season or by wind speed and stability
Time-dependent exponential decay of pollutants
Inclusion of building wake and stack-tip downwash effects
Time periods for which concentration or deposition calculations are to to be made (seasonal and/or annual)

in Section 3.1.1.b. Pollutant emission rates may be held constant or varied by season or by wind speed and stability in ISCLT calculations. The program uses seasonal STAR summaries to calculate seasonal and/or annual concentration or deposition values or an annual STAR summary to calculate annual concentration or deposition values. Additionally, monthly STAR summaries may be used to calculate monthly concentration or deposition values.

c. Output Options. Table 4-3 lists the ISCLT program output options. A more detailed discussion of the ISCLT output information is given in Section 4.1.3.

The ISCLT program has the capability to generate a master tape inventory containing all meteorological and source inputs and the results of all concentration or deposition calculations. This tape can then be used as input to future update runs. For example, assume that the user wishes to add a new source and modify an existing source at a previously modeled industrial source complex. Concentration or deposition calculations are made for these or modified sources alone and the results of these calculations in combination with select sources from the original tape inventory are used to generate an updated inventory. That is, it is not necessary to repeat the concentration or deposition calculations for the unaffected sources in the industrial source complex in order to obtain an updated estimate of the concentration or deposition values for the combined emissions. The optional master tape inventory is discussed in detail in Section 4.2.4.b.

The ISCLT user may elect to print one or more of the following tables:

- The program control parameters, meteorological input data and receptor data

- The source input data

TABLE 4-3

ISCLT OUTPUT OPTIONS

Master tape inventory of meteorological and source inputs and the results of the concentration or deposition calculations
Printout of program control parameters, meteorological data and receptor data
Printout of tables of source input data
Printout of seasonal and/or annual average concentrations or total seasonal and/or annual deposition values calculated at each receptor for each source or for the combined emissions from a select group of all sources
Printout of the contributions of the individual sources to the 10 highest concentration or deposition values calculated for the combined emissions from a select group of all sources or the contributions of the individual sources to the total concentration or deposition values calculated for the combined emissions from a select group of all sources at 10 user-specified receptors

- The seasonal and/or annual average concentration or total deposition values calculated at each receptor for each source or for the combined emissions from select source groups or all sources

- The contributions of the individual sources to the 10 receptors with highest concentration (or deposition) values obtained from the combined emissions of select groups of sources; or the contributions of each individual source, as well as the combined sources, to a select group of user specified receptor points; or the maximum 10 concentration (or deposition) values for each source and for the combined sources, determined independently of each other

4.1.2 Data Input Requirements

This section provides a description of all input data parameters required by the ISCLT program. The user should note that some input parameters are not read or are ignored by the program, depending on the values assigned to the control parameters (options) by the user.

a. Program Control Parameter Data. These data contain parameters which provide user-control over all program options.

Parameter Name	
ISW(1)	Concentration/Deposition Option -- Directs the program to calculate either average concentration or total deposition. A value of "1" indicates average concentration is to be calculated and a value of "2" indicates total deposition is to be calculated. If this parameter is not punched, the program defaults to "1" or concentration.

Parameter Name	
ISW(2)	Receptor Reference Grid System Option -- Specifies whether a right-handed rectangular Cartesian coordinate system or a polar system is to be input to the program to form the receptor reference grid system. A value of "1" indicates a Cartesian reference grid system is being input and a value of "2" indicates a polar reference grid system is being input. If this parameter is not punched, the program will default to a value of "1".
ISW(3)	Discrete Receptor Option -- Specifies whether a right-handed rectangular Cartesian reference system or polar reference system is used to reference the input discrete receptor points. A value of "1" indicates that the Cartesian reference system is used and a value of "2" indicates that a polar reference system is used. If this parameter is not punched, the program will default to a value of "1".
ISW(4)	Receptor Terrain Elevation Option -- Specifies whether the user desires to input the terrain elevations for each receptor point or to use the program as a flat terrain model. A value of "0" indicates terrain elevations are not to be input and a value of "1" indicates terrain elevations for each receptor point are to be input. Note that terrain elevations cannot be used with the deposition model. The default for this parameter is no terrain or "0".
ISW(5)	Input/Output Tape Option -- Specifies whether tape input and/or output is to be used. A value of "0" indicates no

Parameter Name	
ISW(5) (Cont.)	tape input or output. A value of "1" indicates an output tape or data file is to be produced on the output unit specified by ISW(15). A value of "2" indicates an input tape or data file is required on the input unit specified by ISW(14). A value of "3" indicates both input and output tape or data files are being used. Default for this parameter is no tapes or files. It is the user's responsibility to insure that the correct tapes or files are mounted on the correct units.
ISW(6)	Print Input Data Option -- Specifies what input data are to be printed. A value of "0" indicates no input data are to be printed. A value of "1" indicates only the control parameters, receptor points and meteorological data are to be printed. A value of "2" indicates only the source input data are to be printed and a value of "3" indicates all input data are to be printed. The default for this parameter is "0".
ISW(7)	Seasonal/Annual Print Option -- Specifies whether seasonal concentration (or deposition) values are to be printed, or annual values only, or both seasonal and annual values. An ISW(7) value of "1" indicates only seasonal output is to be printed, a value of "2" indicates only annual output is to be printed, and a value of "3" indicates both seasonal and annual output are to be printed. If this parameter is not punched or is "0", the program defaults to "3".
ISW(8)	Individual/Combined Sources Print Option -- Specifies whether output for individual sources or the combined

Parameter Name	
ISW(8) (Cont.)	sources (sum of sources) or both is to be printed. An ISW(8) value of "1" indicates output for individual sources only is to be printed, a value of "2" indicates output for the combined sources only is to be printed, and a value of "3" indicates output for both individual and combined sources is to be printed. The default for this parameter is "3". This parameter is used in conjunction with the parameter NGROUP below. If NGROUP equals "0", all sources input to the program are considered for output under ISW(8). However, if NGROUP is greater than "0", only those sources explicitly or implicitly defined under NGROUP are considered for output under ISW(8). Also, a single source defined under NGROUP is logically treated as combined source output when ISW(8) equals "2" or "3".
ISW(9)	Rural/Urban Option -- Specifies whether rural or urban modes of adjustment of stability categories are to be used (see Table 2-3). A value of "1" specifies Urban Mode 1 and the E and F stability categories are redefined as D. A value of "2" specifies Urban Mode 2 and stability categories A and B are redefined as A, C becomes B, D becomes C, and E and F become D. A value of "3" specifies the Rural Mode and does not redefine the stability categories. If this parameter is not punched or is "0", the program defaults to "3". If tape input is used, the program defaults to the value saved on tape. The parameter ISW(9) is only used for card input sources and/or tape input sources when ISW(12) equals "1". It should be noted that the use of Urban Mode 2 generally is not recommended for regulatory purposes.

Parameter Name	
ISW(10)	Maximum 10 Print Option — Specifies whether the maximum 10 values of concentration or deposition only are to be printed, or the results of the calculations for all receptors only, or both are to be printed. A value of "1" directs the program to calculate and print only the maximum 10 values and receptors according to ISW(11) or ISW(12) below. Values at receptors other than the maximum 10 are not printed if this option equals "1". A value of "0" directs the program to print the results of the calculations at all receptors; the maximum 10 values are not produced. A value of "2" directs the program to print the results of the calculations at all receptor locations as well as the maximum 10. The default for this parameter is "0". The ISCLT program will print less than 10 values in cases where there are less than 10 concentration (deposition) values greater than zero calculated.
ISW(11)	Maximum 10 Calculation Option 1 -- This option directs the program to use one of two methods to calculate and print maximum 10 concentration (or deposition) values. If this option is used, option ISW(12) must equal "0". The program determines the maximum values and receptor locations from the set of all receptors input. Method 1: A value of "1" directs the program to calculate and print the maximum 10 values and respective receptors for each individual source and to calculate and print the maximum 10 values and respective receptors for the combined sources independently of each other. The output

Parameter
Name

for individual sources and combined sources will in general show a different set of receptors.

Method 2: A value of "2" directs the program to first calculate and print the maximum 10 values and respective receptors for the combined sources (sum of sources) and then print the contribution at each receptor of each individual source to the combined sources maximum 10. This option can only be used if one or more of the following conditions is met:

Condition a -- The run uses an output tape or data file (user must specify NOFILE, if tape)

ISW(11)
(Cont.)

Condition b — The run uses an input tape or data file, but has no input data card sources (all are taken from tape) (user must specify NOFILE, if tape)

Condition c -- The total number of input sources is less than or equal to the minimum of I and J, where

$$\left.\begin{array}{l} J = 300 \\ \text{and} \\ I = \left[\dfrac{\left(E - \left(N_x+N_y+2\cdot N_{xy}\right) - K-L\right)}{\left(N_s\cdot\left(N_x\cdot N_y+N_{xy}\right)\right)}\right] \end{array}\right\} \quad (4\text{-}1)$$

Parameter Name	
ISW(11) (Cont.)	E = the total amount of program data storage in BLANK COMMON. The design size is 40,000. N_x = number of points in the input X-axis of the receptor grid system (NXPNTS) N_y = number of points in the input Y-axis of the receptor grid system (NYPNTS) N_{xy} = number of discrete (arbitrarily placed) input receptors (NXWYPT) N_s = number of seasons in the input meteorological data (NSEASN) $K = N_s \cdot (N_x \cdot N_y + N_{xy})$ $L = \begin{cases} 0 ; & \text{if ISW(4) = "0"} \\ N_x \cdot N_y + N_{xy} ; & \text{if ISW(4) = "1"} \end{cases}$
ISW(12)	Maximum 10 Calculation Option 2 — This option directs the program to calculate concentration or deposition at a special set of user supplied discrete (arbitrarily placed) receptor points. If this option is used, option ISW(11) must equal "0". A value of "1" directs the program to

Parameter Name	
ISW(12) (Cont.)	expect to read from 10 to 50 special receptors at which concentration or deposition is to be calculated. If this option is selected and 10 special receptors are input, both seasonal and annual concentration or deposition values for individual sources and combined sources are printed for the 10 user-specified receptors. If more than 10 special receptors are input, the program assumes the first 10 points are for season 1, the second 10 points are for season 2 and the last 10 points are for annual tables. This option requires the parameter NXWYPT given below to be a multiple of 10. All input tape or data file sources are recalculated with this option. Also, if an input tape is being used, the receptor grid system, discrete receptors and their elevations input from the tape are discarded and the user inputs the new special set of receptor points (with elevations if ISW(4) equals "1") via data card.
ISW(13)	Print Output Unit Option -- This option is provided to enable the user to print the program output on a unit other than print unit "6". If this value is not punched or a "0" is punched, all print output goes to unit "6". Otherwise, print output goes to the specified unit. Also, if this value is punched non-zero positive, two end-of-file marks are written at the end of the print file. If ISW(13) is a negative value, the end-of-file marks are not written.
ISW(14)	Optional Tape Input Unit Number — This option is provided to enable the user to assign the unit number from which tape or data file data are read under ISW(5). If ISW(14)

Parameter Name	
ISW(14) (Cont.)	is not punched or is "0", the program defaults to unit "2". If the input data are being read from a mass-storage file, ISW(14) must be set to a negative value. A positive value implies magnetic tape. Note that ISW(14) is the internal file name used by the program to reference the data file and must be equated with the external file name used to assign the file (see Section 4.2.2).
ISW(15)	Optional Tape Output Unit Number -- This option is provided to enable the user to assign the unit number to which tape or output file data are written under ISW(5). If ISW(15) is not punched or is "0", the program defaults to unit "3". If the output data are being written to a mass-storage file, ISW(15) must be set to a negative value. A positive value implies magnetic tape. Note that ISW(15) is the internal file name used by the program to reference the data file and must be equated with the external file name used to assign the file (see Section 4.2.2).
ISW(16)	Print Output Paging Option -- This option enables the user to minimize the number of print output pages. A value of "1" directs the program to minimize the output pages by not starting a new page with each type of output table. If this option is not punched or is "0", the program will start each unrelated output table on a new page. The user is cautioned not to exercise this option until familiar with the output format because the condensed listing may be confusing.

Parameter Name	
ISW(17)	Lines Per Page Option — This option is provided to enable the user to specify the number of print lines per page on the output printer. The correct number of lines per page is necessary for the program to maintain the output format. If this value is not punched or is "0", the program defaults to 57 print lines per page.
ISW(18)	Optional Format for Joint Frequency of Occurrence -- This parameter is a switch used to inform the program whether it is to use a default format to read the joint frequency of occurrance of speed and direction (FREQ) or to input the format via data card. If this option is not punched or is "0", the program uses the default format given under FMT below. If this option is set to a value of "1", the array FMT below is read by the program.
ISW(19)	Option to Calculate Plume Rise as a Function of Downwind Distance -- This option is applicable to all stack sources and if set equal to "0" or not punched, the downwind distance is not considered in calculating the plume rise. If ISW(19) is set equal to "1", the plume rise calculation is a function of downwind distance.
ISW(20)	Option to Add the Briggs (1973) Stack-Tip Downwash Correction to Stack Sources -- This option is applicable to all stack sources and if set equal to "0" or not punched, no downwash correction is made. If ISW(20) is set equal to "1", the Briggs (1973) downwash correction is applied to the stack height for all stack sources.

Parameter Name	
NSOURC	Number of Data Card Input Sources — This parameter specifies the number of input card image sources. This includes card images that specify a new source being entered and card images that specify modifications or deletions to sources input from tape or data file. If this value is not punched or is "0", the program assumes all sources are input from tape or data file. Also, if a negative value is punched for this parameter, the program will continue to read source data card images until it encounters an end-of-file or a negative source identification number in the parameter NUMS below. There is no limit to the number of sources the program can process.
NGROUP	Number of Source Combination Groups -- This parameter is used to select concentration (deposition) calculations for specific sources or source combinations to be printed under the parameter ISW(8) above. A source combination consists of one or more sources and is the sum of the concentrations (deposition) calculated for those sources. If the user desires only individual source output or only all sources combined or both, the parameter NGROUP is not punched or is set equal to "0" and ISW(8) is set according to which option the user desires. Also, if NGROUP is not punched or is set equal to "0", the parameters NOCOMB and IDSOR below are omitted from the input data. However, if NGROUP is set greater than zero, the program assumes the user desires to restrict the output of concentration tables to select individual sources or select combinations of sources or both, depending on ISW(8). The maximum value for NGROUP is 20. If more than 20 source combinations are desired they must be produced in multiple runs of ISCLT. This can be

Parameter
Name

done by specifying an output tape or data file on the first execution. The user would then use this tape for input on subsequent runs to produce the remaining desired source combinations. Also, only a few of the data cards and values from the initial data deck are required on subsequent runs. The parameter NGROUP cannot be used or punched non-zero unless one or more of the following conditions is met:

Condiiton a — The run uses an output tape or data file (user must specify NOFILE, if tape)

Condition b -- The run uses an input tape or data file, but has no input data card sources (all are taken from tape, NSOURC = "0") (user must specify NOFILE, if tape).

NGROUP
(Cont.)

Condition c — The total number of input sources (NSOURC + input tape sources) is less than or equal to the minimum of I and J, where

$$\left.\begin{aligned} J &= 300 \\ &\text{and} \\ I &= \frac{\left(E - \left(N_x + N_y + 2N_{xy}\right) - K - L\right)}{\left(N_s\left(N_x \cdot N_y + N_{xy}\right)\right)} \end{aligned}\right\} \quad (4\text{-}2)$$

All of the variables in this equation except K are the same as those defined under ISW(11) above.

Parameter Name

NGROUP (Cont.)

$$K = \begin{cases} 0 & ; \text{ if } ISW(8)=1 \text{ and } ISW(11)\neq 2 \\ N_s\left(N_x \cdot N_y + N_{xy}\right) & ; \text{ if } ISW(8)\neq 1 \text{ or } ISW(11)=2 \end{cases}$$

X-Axis/Range Receptor Grid Size -- This parameter specifies the number of east-west receptor grid locations for the Cartesian coordinate system X-axis, or the number of receptor grid ranges (rings) in the polar coordinate system, depending on which receptor grid system is chosen by the user under parameter ISW(2). This is the number of X-axis points to be input or the number of X-axis points to be automatically generated by the program. A value of "0" (not punched) directs the program to assume there is no regular receptor grid being used. The maximum value of this parameter is related to other parameter values and is given by the equation

NXPNTS

$$E \geq \left[N_x + N_y + 2N_{xy}\right] + \left[(K \cdot N_s + I)\ (N_x \cdot N_y + N_{xy})\right] \qquad (4\text{-}3)$$

where all variables in the above equation are the same as those defined under ISW(11) above except K and I, which are defined as

$$K = \begin{Bmatrix} 1 & ; \text{ if } ISW(8)=1 \text{ and } ISW(11)\neq 2 \\ 2 & ; \text{ if } ISW(8)\neq 1 \text{ or } ISW(11)=2 \end{Bmatrix}$$

Parameter Name	
NXPNTS (Cont.)	$I = \left\{ \begin{array}{ll} 0 \;; & \text{if ISW(4)=0 (no terrain)} \\ 1 \;; & \text{if ISW(4)=1} \end{array} \right\}$ This parameter is ignored by the program if tape or data file input is being used.
NYPNTS	Y-Axis/Azimuth Receptor Grid Size -- This parameter specifies the number of north-south receptor grid locations for the Cartesian coordinate system Y-axis, or the number of receptor azimuth bearings from the origin in the polar coordinate system, depending on which receptor grid system is chosen by the user under parameter ISW(2). This is the number of Y-axis points to be input or the number of Y-axis points to be automatically generated by the program. If the parameter NXPNTS is set non-zero, the parameter NYPNTS must also be non-zero. The maximum value of this parameter is given by the equation under NXPNTS above. The parameter NYPNTS is ignored by the program if tape or data file input is being used.
NXWYPT	Number of Discrete (Arbitrarily Placed) Receptors -- This parameter specifies the total number of discrete receptor points to be input to the program. A value of "0" (not punched) directs the program to assume no discrete receptors are being used. This parameter must be set to a multiple of 10 if option ISW(12) above is selected. Also, the maximum value of this parameter is limited by the equation given under NXPNTS above. This parameter is ignored by the program if input tape or data file is being used, except in the case where the ISW(12) option has been selected.

Parameter Name	
NSEASN	Number of Seasons -- This parameter specifies the number of seasons or months in the input meteorological data. A value of "0" (not punched) defaults to "1". Also, if annual meteorological data are being used, a value of "1" should be specified. The maximum value of this parameter is "4". If monthly STAR summaries and seasonal average mixing heights and ambient air temperatures are used to calculate monthly concentration or deposition values for each month of the year, four separate program runs, each containing three "seasons" (months), are required. This parameter is ignored by the program if an input tape or data file is being used.
NSPEED	Number of Wind Speed Categories -- This parameter specifies the number of wind speed categories in the input joint frequency of occurrence of wind speed and direction (FREQ). A value of "0" (not punched) causes the program to default to "6" (maximum). This parameter is ignored by the program if an input tape or data file is being used.
NSTBLE	Number of Pasquill Stability Categories -- This parameter specifies the number of Pasquill stability categories in the input joint frequency of occurrence of wind speed and direction (FREQ). A value of "0" (not punched) causes the program to default to "6" (maximum). This parameter is ignored by the program if an input tape or data file is being used.

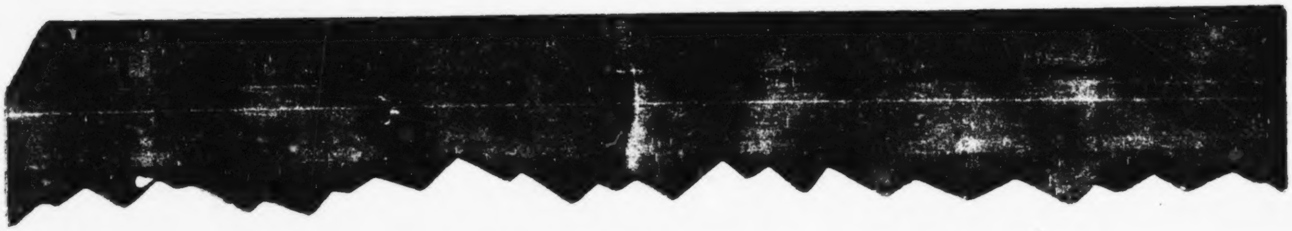
Parameter Name	
NSCTOR	Number of Wind Direction Sector Categories — This parameter specifies the number of wind direction sector categories in the input joint frequency of occurrence of wind speed and direction (FREQ). A value of "0" (not punched) causes the program to assume the standard "16" (maximum) sectors are to be used (see Section 2.2.1.2). This parameter is ignored by the program if an input tape or data file is being used.
NOFILE	Tape Data Set File Number -- This parameter specifies the output tape file number or, if only an input tape is being used, the input tape file number. This parameter is used by the ISCLT program to position the tape at the correct file if multiple passes through the data are required. This parameter must be input if the user is using Condition a or Condition b under ISW(11) and/or under NGROUP. This parameter does not apply to runs that use mass-storage (assumed one file) or runs that satisfy Condition c under ISW(11) and/or NGROUP. Also, the user must position input and output tapes at the correct files prior to executing the ISCLT program.
NOCOMB	Number of Sources Defining Combined Source Groups -- This parameter is not read by the program if the parameter NGROUP above is zero or not punched. Otherwise, this parameter is an array of NGROUP values where each value gives the number of source identification numbers used to define a source combination. The source identification number is that number assigned to each source by the user under the source input parameter NUMS below. An example

Parameter Name	
NOCOMB (Cont.)	and a more detailed discussion of the use of this parameter is given under IDSORC below. A maximum of 20 values is provided for this array.
IDSOR	Combined Source Group Defining Sources — This parameter is not read by the program if the parameter NGROUP above is zero or not punched. Otherwise, this parameter is an array of source identification numbers that define each combined source group to be output. The values punched into the array NOCOMB above indicate how many source identification numbers are punched into this array successively for each combined source output. The source identification numbers can be punched in two ways. The first is to punch a positive value directing the program to include that specific source in the combined output. The second is to punch a negative value. When a negative value is punched, the program includes all sources with identification numbers less than or equal to it in absolute value. Also, if the negative value is preceded by a positive value in the same defining group, that source is also included with those defined by the negative number, but no sources with a lesser source identification number are included. For example, assume NGROUP above is set equal to 4 and the array NOCOMB contains the values 3, 2, 1, 0. Also, assume the entire set of input sources is defined by the source identification numbers 5, 72, 123, 223, 901, 902, 1201, 1202, 1205, 1206 and 1207. To this point we have a total of 11 input sources and we desire to see 4 combinations of sources taken from these 11. Also, the array NOCOMB indicates that the first 3

Parameter Name	
IDSOR (Cont.)	values in the array IDSORC define the first source combination, the next 2 values (4th and 5th) in IDSORC define the second combination, the 6th value in IDSORC defines the third combination and the last combination has no defining (0) sources so the program assumes all 11 sources are used. Similarly, let the array IDSORC be set equal to the values 5, 72, -223, 1201, -1207, -902. The program will first produce combined source output for source 5, and all sources from 72 through 223. The second combined source output will include sources 1201 through 1207. The third will include source numbers 1 through 902 and the last will include all sources input. Note that the source identification numbers in each defining group are in ascending order of absolute value. Also, if ISW(8) equals "2" (combined output only) and there are groups with only one positive source number (individual sources), the program logically treats these individual sources as combined sources.
FMT	Optional Format for Joint Frequency of Occurrence — This parameter is an array which is read by the program only if ISW(18) is set to a value of "1". The array FMT is used to specify the format of the joint frequency of occurrence of wind speed and direction data (FREQ, STAR summary, $f_{i,j,k,\ell}$ in Table 2-4). The format punched, if used, must include leading and ending parentheses. If ISW(18) is not punched or is set to a value of "0", the parameter FMT is omitted from the input deck and the program uses the default format "(6F10.0)". This default format specifies that there are 6 real values per card occupying 10 columns each, including the decimal point (period), and the first value is punched in columns one through ten. If the user has received the STAR data from

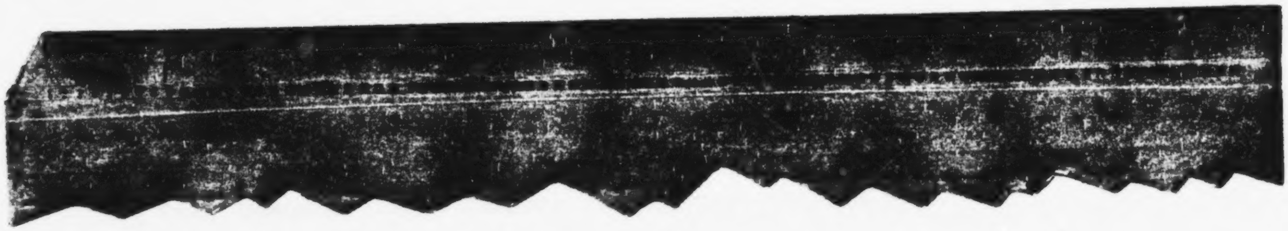
Parameter
Name

an outside source, the deck must also be checked for the proper order as well as format and, if the order is not correct, the data must be repunched. The correct order of the STAR data is given under FREQ below. An example of a STAR deck punched in a format not compatible with the default format for FMT is



FMT
(Cont.)

This example shows the stability and direction categories punched in columns 1 through 17 and the frequency of occurrence data occupying columns 20 through 73. To input these data the user would set ISW(18) equal to "1" and punch the format (FMT) as shown on the following example input data card



This format directs the ISCLT program to skip the first 19 columns on each frequency of occurrence card read and

Parameter Name	
FMT (Cont.)	to read six equally-spaced real values from the card. Each value occupies 9 columns including the decimal point (period). The first value begins in column 20. The program interprets the leading blank character of each value as zero.

b. Receptor Data. These data consist of the (X,Y) or (range, azimuth) locations of all receptor points as well as the elevations of the receptors above mean sea level.

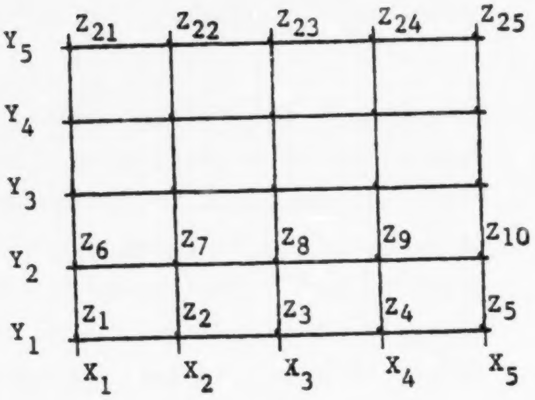
Parameter Name	
X	Receptor Grid System X-Axis or Range -- This parameter is read by the program only if the parameters NXPNTS and NYPNTS are non-zero and only if an input tape or data file is not being used. This parameter is an array of values in ascending order that defines the X-axis or ranges (rings) (depending on ISW(2)) of the receptor grid system in meters. If only the first 2 values on the input card are punched and the parameter NXPNTS is greater than 2, the program assumes the X-axis (range) is to be generated automatically and assumes the first value punched is the starting coordinate and the second value punched is an increment used to generate the remaining NXPNTS evenly-spaced points. If all receptor points are being input, NXPNTS values must be punched. The origin of the grid system is defined by the user and can be anywhere.

Parameter Name	
Y	Receptor Grid System Y-Axis or Azimuth -- This parameter is read by the program only if the parameters NXPNTS and NYPNTS are non-zero and only if an input tape or data file is not being used. This parameter is an array of values in ascending order that defines the Y-axis or azimuth bearings (depending on ISW(2)) of the receptor grid system in meters or degrees. If only the first 2 values on the input card are punched (third and fourth values are zero) and the parameter NYPNTS is greater than 2, the program assumes the first value punched is the starting coordinate and the second value punched is the increment used to generate the remaining NYPNTS evenly-spaced (rectangular or angular) points. If all receptor points are being input, NYPNTS values must be punched. If polar coordinates are being used, Y is measured clockwise from zero degrees (north).
X (Discrete)	Discrete (Arbitrarily Placed) Receptor X or Range -- This parameter is not read by the program if the parameter NXWYPT is zero or if the program is using an input tape or data file with the ISW(12) option set to zero. This parameter is an array defining all of the discrete receptor X points. The values are either east-west distances or radial distances in meters, depending on the type of reference system specified by ISW(3). NXWYPT points are read by the program. The origin of these points is the same as the origin of the regular (non-discrete) grid system if one is used. Otherwise, the origin is defined by the user and can be located anywhere.

Parameter Name	
Y (Discrete)	Discrete (Arbitrarily Placed) Receptor Y or Azimuth — This parameter is not read by the program if the parameter NXWYPT is zero or if the program is using an input tape or data file with the ISW(12) option set to zero. This parameter is an array defining all of the discrete receptor Y points in meters or degrees. The values are either north-south distances or azimuth bearings (angular distances) measured clockwise from zero degrees (north) depending on the type of reference system specified by ISW(3). NXWYPT points are read by the program.
Z	Elevation of Grid System Receptors -- This parameter is not read by the program if the parameter ISW(4) is zero or if an input tape is being used or if NXPNTS or NYPNTS equals zero. This parameter is an array specifying the terrain elevation in feet above mean sea level at each receptor of the Cartesian or polar grid system. There are NXPNTS • NYPNTS values read into this array. The program starts the input of values with the first Y coordinate specified and reads the elevations for each X coordinate at that Y in the same order as the X coordinates were input. A new data card is started for each Y value and the NXPNTS elevations for that Y are read. The program will expect NYPNTS groups of data cards with NXPNTS elevation values punched in each group. For example, assume we have a 5 by 5 Cartesian or polar receptor array:

Parameter
Name

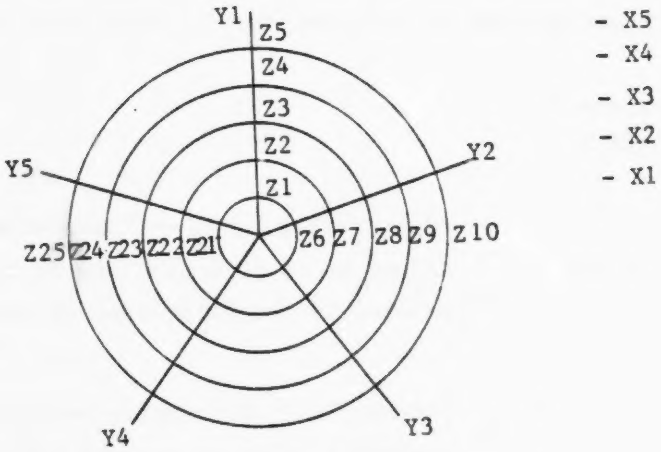
Rectangular



Z21
Z22
Z23
Z24
Z25
Y5
Y4
Y3
Z6
Z7
Z8
Z9
Z10
Y2
Z1
Z2
Z3
Z4
Z5
Y1
X1
X2
X3
X4
X5

Z
(Cont.)

Polar



Y1
Z5
Z4
Z3
Z2
Z1
Y5
Y2
Z25
Z24
Z23
Z22
Z21
Z6
Z7
Z8
Z9
Z10
Y4
Y3
- X5
- X4
- X3
- X2
- X1

Parameter Name	
Z (Cont.)	The values Z_1 through Z_5 are read from the first card group, the values Z_6 through Z_{10} from the second card group and Z_{21} through Z_{25} from the last card group.
Z (Discrete)	Elevation of the Discrete (Arbitrarily Placed) Receptors -- This parameter is not read by the program if the parameter ISW(4) is zero or if the parameter NXWYPT equals zero or if an input tape is being used with the ISW(12) option equal to zero. This parameter, which is an array specifying the terrain elevation in feet at each of the NXWYPT discrete receptors, is input in the same order as the discrete receptors.

c. Identification Labels and Model Constants. These data consist of parameters pertaining to heading and identification labels and program constants. These data except for TITLE are not read by the program if an input tape or data file is being used.

Parameter Name	
TITLE	Page Heading Label -- This parameter is an array that allows up to 80 characters of title information to be printed as the first line of each output page.
UNITS	Concentration/Deposition and Source Units Label -- This parameter is an array used for the optional input of two units labels. The first 40 characters of this array are provided for an optional output units label for concentration or deposition. This label is defaulted to "micrograms per cubic meter" for concentration and "grams per

Parameter Name	
UNITS (Cont.)	square meter" for deposition, if the parameter TK below is not punched or is "0". The second 40 characters of this array are provided for an optional source input units label. This label is defaulted to "grams per second" for concentration or "grams" for deposition for stacks and volume sources and to "grams per second per square meter" or "grams per square meter" for area sources, if the parameter TK below is not punched or is "0".
ROTATE	Wind Direction Correction Angle -- This parameter is used to correct for any difference between north as defined by the X, Y reference grid system and north as defined by the weather station at which the wind direction data were recorded. The value of ROTATE (degrees) is subtracted from each wind-direction sector angle (THETA). This parameter is positive if the positive Y axis of the reference grid system points to the right of north as defined by the weather station. Most weather stations record direction relative to true north and the center of most grid systems are relative to true north. However, some weather stations record direction relative to magnetic north and the ends of some UTM (Universal Transverse Mercator) zones are not oriented towards true north. The user is cautioned to check the wind data as errors in the wind direction distribution will lead to erroneous program results. The default value of ROTATE is zero.
TK	Model Units Conversion Factor -- This parameter is provided to give the user flexibility in the source input units used and the concentration or deposition output units desired. This parameter is a direct multiplier of

Parameter Name	
TK (Cont.)	the concentration or deposition equation. If this parameter is not punched or is set to a value of "0", the program defaults to "1 x 10^6" micrograms per gram for concentration and to "1" for deposition. This default assumes the user desires concentration in micrograms per cubic meter or deposition in grams per square meter and the input source units are grams per second or total grams for stack and volume sources and grams per second per square meter or grams per square meter for area sources, depending on whether the program is to calculate concentration or deposition. Also, if the default value for this parameter is selected, the program defaults the units labels in the array UNITS above. If the user chooses to input this parameter for other units, he must also input the units labels in UNITS above. This parameter corresponds to K in Equations (2-46), (2-53), (2-54) and (2-55).
ZR	Weather Station Recording Height -- This parameter is the height above ground level in meters at which the meteorological data were recorded. If this parameter is not punched or has a value of "0", the program defaults to "10" meters. This parameter corresponds to Z_1 in Equation (2-10).
BETA1	Adiabatic/Unstable Entrainment Coefficient -- This parameter, which is used in plume rise calculations, is the air entrainment coefficient for an adiabatic or unstable atmosphere. If this value is not punched or is "0", the program uses "0.6" as the default value. This parameter corresponds to β_1 in Equation (2-4).

Parameter Name	
BETA2	Stable Entrainment Coefficient -- This parameter, which is used in the plume rise calculations, is the air entrainment coefficient for a stable atmosphere. If this value is not punched or is "0", the program uses "0.6" as the default value. This parameter corresponds to β_2 in Equation (2-7).
G	Acceleration Due to Gravity -- This parameter, which is used in the plume rise calculations, is the acceleration due to gravity. If this parameter is not punched or has a value of "0", the program uses "9.8" meters per second squared as the default value. This parameter corresponds to g in Equation (2-2).
DECAY	Decay Coefficient -- This parameter is the coefficient (seconds^{-1}) of time-dependent pollutant removal by physical or chemical processes (Equations (2-13), (2-14)). The default for this parameter is "0".

d. Meteorological Data. These data are the meteorological input parameters classified according to one or more of the categories of wind speed, Pasquill stability, wind direction and season or annual. These parameters are not read by the program if an input tape or data file is being used.

Parameter Name	
FREQ	Joint Frequency of Occurrence -- This parameter array consists of the seasonal or annual joint frequency of

Parameter Name	
FREQ (Cont.)	occurrence of wind-speed and wind-direction categories classified according to the Pasquill stability categories (STAR summary, $f_{i,j,k,\ell}$ in Table 2-4). This parameter has no default and must be input in the correct order. The program begins by reading the joint frequency table for season 1 (winter) and stability category 1 (Pasquill A stability). The first data card contains the joint frequencies of wind speed categories 1 through 6 (1 through NSPEED) for the first wind direction category (north). The second data card contains the joint frequencies of wind speed categories 1 through 6 for the second wind direction category (north-northeast). The program continues in this manner until the joint frequencies of the last direction category (north-northwest) for stability category 1, season 1 have been read. The program then repeats this same read sequence for stability category 2 (Pasquill B stability) and season 1. When all of the stability category values for season 1 have been read, the program repeats the read sequence for season 2, season 3, etc., until all of the joint frequency values have been read. There are a total of NSPEED*NSCTOR*NSTBLE*NSEASN values read in this data card group and a total of NSCTOR*NSTBLE*NSEASN data cards. If the total sum of the joint frequency of occurrences for any season (or annual) does not add up to 1, the program will automatically normalize the joint frequency distribution by dividing each joint frequency by the total sum. Also, the program assumes stability categories 1 through 6 are Pasquill stabilities A through F. Seasons 1 through 4 are normally winter, spring, summer and fall. See the parameter FMT above for the format of these data.

Parameter Name	
TA	Average Ambient Air Temperature -- This parameter array consists of the average ambient air temperatures ($T_{a;k,\ell}$ in Table 2-4), classified according to season (or annual) and stability category, in degrees Kelvin. One data card is read for each season (1 to NSEASN) with the temperature values for stability categories 1 through NSTBLE punched across the card. When the program has completed reading these data cards, it will scan all of the values in the order of input and, if any value is not punched or is zero, the program will default to the last non-zero value of TA it encountered.
HM	Mixing Heights -- This parameter array consists of the median mixing layer height in meters ($H_{m;i,k,\ell}$ in Table 2-4) classified according to wind speed, stability and season (or annual). The program begins reading the mixing layer heights for season 1. The program reads the mixing layer height values for each wind speed category (1 to NSPEED) from each card. There are NSTBLE (1 through NSTBLE) cards read for each season. The program scans each value input in the order of input and, for each season, if a zero or non-punched value is found, the program defaults to the last non-zero value encountered within the values for that season. The ISCLT program automatically uses a mixing height value of 10000 meters for the E and F stability categories when the program is run in the Rural Mode.
DPDZ	Potential Temperature Gradient -- This parameter array consists of the vertical gradients of potential temperature

Parameter Name	
DPDZ (Cont.)	($\frac{\partial \theta}{\partial z}_{i,k}$ in Table 2-4) classified according to wind speed and stability category in units of degrees Kelvin per meter. There are NSTBLE (1 through NSTBLE) data cards read with the values for wind speed categories 1 through NSPEED read from each card. If the first value on a data card is not punched or is zero for cards 1 through 4 (Pasquill stability A through D), the potential temperature gradients are set equal to zero by the program for these stability categories. If the first value on cards 5 or 6 (E and F) is zero or not punched the program defaults to a value of 0.02 for card 5 (E stability) and 0.035 for card 6 (F stability). Also, if the second through last value on any card is zero or not punched, the program defaults to the last non-zero value found in a scan of the data card.
UBAR	Wind Speed -- This parameter array consists of the median wind speeds in meters per second ($\bar{u}_1$ in Table 2-4) for the wind-speed categories used in the calculation of the joint frequency of occurrence of wind speed and direction (STAR summary). There are NSPEED values read from this card and if any value is not punched or is zero, the program defaults to the following set of values: 0.75, 2.5, 4.3, 6.8, 9.5 and 12.5 meters per second.
THETA	Wind Direction -- This parameter array consists of the median wind direction angles in degrees for the wind-direction categories used in the calculation of the joint frequency of occurrence of wind speed and direction (STAR summary). There are NSCTOR values read from 1 to 2 data

Parameter Name	
THETA (Cont.)	cards and if the first two values of this array are not punched or are zero, the program defaults to the following standard set of values: 0, 22.5, 45, 67.5, 90, . . ., 337.5 degrees (N, NNE, NE, . . ., NNW). The wind direction is that angle from which the wind is blowing, measured clockwise from zero degrees (north).
P	Wind Speed Power Law Exponent -- This parameter array consists of the wind speed power law exponents (p in Equation (2-10)) classified according to wind speed and stability category. There are NSPEED (1 through NSPEED) values read per data card for stability categories 1 through NSTBLE. If the first value on any data card in this set is not punched or is zero, the program defaults to the value from the following set of values: A = 0.1, B = 0.15, C = 0.2, D = 0.25, E = 0.3, F = 0.3 depending on the stability category A through F. Also, if any of the second through last value on a card is not punched or is zero, the value is defaulted to the previous non-zero value on the data card.

e. Source Data. These data consist of all necessary information required for each source. These data are divided into three groups: (1) parameters that are required for all source types, (2) parameters that are required for stack type sources, and (3) parameters that are required for volume sources and area sources. The order of input of these parameters is given at the end of this section.

Parameter Name	
NUMS	Source Identification Number -- This parameter is the source identification number and is a 1- to 5-digit integer. If this number is negative, the program assumes NUMS is only a flag to terminate the card source input data. Also, if NUMS is not punched or is zero, the program will default NUMS to the relative sequence number of the source input. This number cannot be defaulted if source data are also being input from tape or data file. Sources must be input in ascending order of the source identification number.
DISP	Source Disposition -- This parameter is a flag that tells the program what to do with the source. If this parameter is not punched or has a value of "0", the program assumes this is a new source for which concentration or deposition is to be calculated. Also, if the program is using an input tape or data file, this new source will be merged into the old sources from tape or will replace a tape source with the same source identification number. If the parameter DISP has a value of "1", the program assumes that the tape input source having the same source identification number is to be deleted from the source inventory. The program removes the source as well as the concentration or deposition arrays for the source. If the parameter DISP has a value of "2", the program assumes the source strengths to be read from data card for this source are to be used to rescale the concentration or deposition values of the tape input source with the same source identification number. The new source strengths input from card replace the old values taken

Parameter Name	
DISP (Cont.)	from the input tape and the concentration or deposition arrays taken from tape are multiplied by the ratio of the new and old source strengths. The DISP option equal to "2" can only be used if QFLG equals zero and the tape input source has QFLG equal to zero.
TYPE	Source Type -- This parameter is a flag that tells the program what type of source is being input. If this parameter is not punched or is "0", the program assumes a stack source. If this parameter has a value of "1", the program assumes a volume source. Similarly, if this parameter has a value of "2", an area source is assumed.
QFLG	Source Emissions Option -- This parameter is a flag that tells the program how the input source emissions are varied. If this value is not punched or is "0", the program assumes the source emissions vary by season (or annual) and only the NSEASN values are read by the program. If this parameter has a value of "1", the program assumes the source emissions vary by stability category and season. If this parameter has a value of "2", the program assumes the source emissions vary by wind speed category and season. If this parameter has a value of "3", the program assumes the source emissions vary by wind speed category, stability category and season. The order of input of the source strengths under each of these options is discussed under the parameter Q below.
DX	Source X Coordinate -- This parameter gives the Cartesian X (east-west) coordinate in meters of the source center

Parameter Name	
DX (Cont.)	for stack and volume sources and the southwest corner for area sources (X in Table 2-6) relative to the origin of the reference grid system being used.
DY	Source Y Coordinate -- This parameter gives the Cartesian Y (north-south) coordinate in meters of the source center for stack and volume sources and the southwest corner for area sources (Y in Table 2-6) relative to the origin of the reference grid system being used.
H	Height of Emission -- This parameter gives the height above ground in meters of the pollutant emission. For volume sources, this is the height to the center of the source.
ZS	Source Elevation -- This parameter gives the terrain elevation in meters above mean sea level at the source location and is not used by the program unless receptor terrain elevations (ISW(4)) are being used.
Q	Source Emission -- This parameter array gives the emission rate of the source for each category specified by QFLG above. If QFLG above is "0", NSEASN values are read from one data card. If QFLG is "1", NSEASN data cards are read with the source emission values for stability categories 1 through NSTBLE read from each card. If QFLG is "2", NSEASN data cards are read with the source emission values for wind speed categories 1 through NSPEED read from each card. If QFLG is "3", NSPEED (1 through

Parameter
Name

NSPEED) source emission values are read from each data card and there are NSTBLE (1 through NSTBLE) data cards read for each season. There are no default values provided for the parameter Q and the program assumes "0" is a valid source emission. The input units of source emission are:

Q
(Cont.)

Source Type	Concentration	Deposition
stack or volume	mass per unit time (g/sec)*	total mass (g)*
area	mass per unit time per unit area $(g/(sec \cdot m^2))$*	total mass per unit area (g/m^2)*

*Default units

NVS

Number of Particulate Size Categories -- This parameter gives the number of particulate size categories in the particulate distribution used in calculating ground-level deposition or concentration with deposition occurring. If ground-level deposition (ISW(1) = "2") is being calculated, this parameter must be punched and has a maximum value of 20. Also, if the program is calculating concentration and this value is punched greater than zero, concentration with deposition occurring is calculated. If the parameter NVS is greater than zero, the program reads NVS values for each of the parameter variables VS, FRQ and GAMMA below.

Parameter Name	
VS	Settling Velocity -- This parameter array is read only if NVS above is greater than zero. This parameter is the settling velocity in meters per second for each particulate size category (1 through NVS). No default values are provided for this parameter.
FRQ	Mass Fraction of Particles -- This parameter array is read only if NVS above is greater than zero. This parameter is the mass fraction of particulates contained in each particulate size category (1 through NVS). No default values are provided for this parameter.
GAMMA	Surface Reflection Coefficient -- This parameter array is read only if NVS above is greater than zero. This parameter is the surface reflection coefficient for each particulate size category (1 through NVS). A value of "0" indicates no surface reflection (total retention). A value of "1" indicates complete reflection from the surface. The reflection coefficient range is from 0 to 1 and no default values are provided.
Stack Source Parameters	
TS	Stack Gas Exit Temperature -- This parameter gives the stack gas exit temperature (T_s in Table 2-6) in degrees Kelvin. If this parameter is zero, the exit temperature is set equal to the ambient air temperature. If this parameter is negative, its absolute value is added to the ambient air temperature to form the stack gas exit temperature. For example, if the stack gas exit temperature is 15 degrees Celsius above the ambient temperature, enter TS as -15 (the minus sign is used by the program only as a flag).

Stack Source Parameters	
VEL	Stack Gas Exit Velocity -- This parameter gives the stack gas exit velocity in meters per second. No plume rise is calculated if VEL is equal to zero.
D	Stack Diameter -- This parameter gives the inner stack diameter in meters and no default is provided.
HB	Building Height -- This parameter gives the height above ground level in meters of the building adjacent to the stack. *This parameter and BW below control the wake effects option. If HB and BW are punched non-zero, wake effects for the respective source are considered.* However, if HB and BW are not punched or both equal "0", wake effects for the respective source are not considered (see Section 2.4.1.1.d).
BW	Building Width -- This parameter gives the width in meters of the building adjacent to the stack. If the building is not square, input the diameter of a circular building of equal horizontal area. If HB is not punched or is zero, this value should not be punched.
WAKE	Supersquat Building Wake Effects Equation Option -- This option is used to control the equations used in the calculation of the lateral virtual distance (Equations (2-31) and (2-33)) when the effective building width to height ratio (BW/HB) is greater than 5. If this parameter is not punched or has a value of "0" and the width to height ratio is greater than 5, the program will use Equation (2-31) to calculate the lateral virtual distance producing the upper bound of the concentration or deposition for the source. If this parameter has a value of "1", the

Stack Source Parameters	
WAKE (Cont.)	program uses Equation (2-33) producing the lower bound of the concentration or deposition for the source. The appropriate value for this parameter depends on building shape and stack placement with respect to the building (see Section 2.4.1.1.d).
Volume Source Parameters	
SIGYO	Standard Deviation of the Crosswind Distribution -- This parameter gives the standard deviation of the crosswind distribution of the volume source (σ_{yo} in Table 2-6) in meters. See Section 2.4.2.3 to determine the correct value for this parameter. No default value is provided.
SIGZO	Standard Deviation of the Vertical Distribution -- This parameter gives the standard deviation of the vertical distribution of the volume source (σ_{zo} in Table 2-6) in meters. See Section 2.4.2.3 to determine the correct value for this parameter. No default value is provided for this parameter.
Area Source Parameters	
XO	Width of Area Source -- This parameter gives the width of the area source (x_o in Table 2-6) in meters. This parameter should be the length of one side of the approximately square area source. No default is provided for this parameter.

f. Source Data Input Order. There are from one to four data input card groups of one or more cards each required to input the source data. The data cards and parameters required depend on the source type (TYPE) and on the parameters DISP, QFLG, NVS and the concentration/deposition option parameter ISW(1). Card Group 17 is always included in the input deck for each source input (1 to NSOURC). Card Groups 17a through 17c are included only if NVS on Card Group 17 is non-zero. Card Group 17d is included only if DISP on Card Group 17 equals "0" or "2". The order of input of these source cards is Card Group 17 followed by those used from 17a through 17d for each successive source input. DO NOT stack all of 17 together, all of 17a together, etc. or the program will terminate in error.

Source Input
Card Group 17

Required Source Parameters for Card Group 17 -- The parameters read from the first data card for each source and their order are:

Stack Sources -- NUMS, DISP, TYPE, QFLG, DX, DY, H,
ZS, TS, VEL, D, HB, BW, WAKE, NVS

Volume Sources -- NUMS, DISP, TYPE, QFLG, DX, DY, H,
ZS, SIGYO, SIGZO, NVS

Area Sources -- NUMS, DISP, TYPE, QFLG, DX, DY, H,
ZS, XO, NVS

If the parameter DISP on this card is set to value of "0", all parameters on this card are expected to have the correct value and the program may read Card Groups 17a, 17b and 17c (depending on NVS) and will read Card Group 17d. If DISP is set to a value of "1", only the parameters NUMS and DISP are referenced (required) on this card, the program assumes it is to delete an incoming tape or data file source and only this data card is read for this

Source Input
Card Group 17
(Cont.)

source. If DISP is set to a value of "2", only the parameters NUMS, DISP and QFLG are referenced (required) on this card because the program assumes it is to read the source strengths from Card Group 17d and to rescale the concentration or deposition of an incoming tape or data file source. Parameters not referenced on this first data card are set from tape or data file source data by the program.

Source Input
Card Groups
17a, 17b
and 17c

Source Particulate Distribution Data -- This card group consists of three sets of one or more data cards each and is read by the program only if DISP is set to "0" and the parameter NVS is set to a value greater than zero for concentration calculations with deposition occuring or for deposition calculations. The first data card(s) contains the values of the parameter array VS, the second contains the values of the parameter array FRQ and the third contains the values of the parameter array GAMMA. A total of NVS values are read from each set of cards.

Source Input
Card Group 17d

Source emissions -- the last input card group for a source contains the source emission values for the source. This card group consists of one or more data cards and is read only if the parameter DISP is not equal to "1". The number of cards required and the order of values input depends on the parameters QFLG and is given under the source strength parameter Q above.

4.1.3 Output Information

The ISCLT program generates five categories of program output. Each category is optional to the user. That is, the user controls what output other than warning and error messages the program generates for a given run. In the following paragraphs, each category of output is related to the specific input parameter that controls the output category. All program output are printed except for magnetic tape or data file output.

a. Input Parameters Output. The ISCLT program will print all of the input data except for source data if the parameter ISW(6) is set equal to a value of "1" or "3". An example of this output is shown in Figure 4-2 of Section 4.2.4 and in the example problems given in Appendix D.

b. Source Parameters Output. The ISCLT program will print the input card and tape source data if the parameter ISW(6) is set to a value of "2" or "3". An example of the printed source data is shown in Figure 4-3 of Section 4.2.4 and in the example problems given in Appendix D.

c. Seasonal/Annual Concentration or Deposition. The parameter ISW(1) specifies whether the program is to calculate concentration or deposition and the parameter NSEASN specifies if seasonal or annual input meteorological data is being used. The option ISW(7) is used to specify whether seasonal output or annual output or both is to be generated. If the input meteorological data are seasonal (winter, spring, summer, fall), the program can be directed to produce tables of seasonal as well as annual concentration or deposition by setting the parameter ISW(7) equal to "0" or "3". Also, only seasonal tables are produced if ISW(7) equals "1". If the parameter NSEASN is set equal to a value of "1" and only annual output is selected (ISW(7)="2"), the program labels the output concentration or deposition as annual calculations. However, if seasonal output is selected with NSEASN equal to "1", the output tables are labeled seasonal. Also, all seasonal output is labeled season 1, season 2, etc., requiring the user to keep track of the actual meteorological season. Example seasonal and annual output tables are shown in Figures 4-4 and 4-5 in Section 4.2.4 as well as Appendix D.

d. Concentration or Deposition Printed for the Maximum 10 and/or All Receptor Points. The ISCLT program is cabable of printing the concentration or deposition calculations for each receptor point input to the program or printing only the maximum 10 of those receptors or both. The parameter ISW(10) is used to determine which calculations are to be printed. If ISW(10) is set equal to "1", only the maximum 10 values and receptors determined by ISW(11) or ISW(12) are printed. If ISW(10) is set equal to "0", the results of calculations at all receptors are printed and the maximum 10 are not printed. If ISW(10) is set equal to "2", the program prints the results of calculations at all receptors in addition to the maximum 10. Examples of output tables giving the calculations at all points and the maximum 10 are given in Figures 4-4 through 4-10 of Section 4.2.4 and in Appendix D.

e. Magnetic Tape or Data File Output. The ISCLT program will write all input data and all concentration (deposition) calculations to magnetic tape or data file. These data are written to the logical unit number specified by the parameter ISW(15). This tape or data file must be assigned to the run prior to the execution of the ISCLT program, positioned to the correct file and must be equated to the logical unit number given in ISW(15). ISW(15) must be a positive value for magnetic tape or a negative value for mass storage. If seasonal meteorological input data are used, the program saves only seasonal concentration (deposition) on the output file and if input is annual, only annual calculations are saved. This output file can be read back into the ISCLT program to print tables not output in the original run and/or to modify the source inventory for corrections or updates in the source emissions. The instructions on how to assign the output magnetic tape or file are given in Section 4.2.2 and approximations as to the length of magnetic tape required are given in Section 4.2.5.c. A more detailed description of the contents and format of the output tape file is given in Section 4.2.4.

4.2 USER'S INSTRUCTIONS FOR THE ISCLT PROGRAM

4.2.1 Program Description

The ISC long-term (ISCLT) program is designed to calculate ground-level average concentration or total deposition values produced by emissions from multiple stack, volume and area sources. The ground-level concentration or total deposition values can be calculated on a seasonal (monthly) or annual basis or both for an unlimited number of sources. The program is capable of producing the seasonal and/or annual results for each individual source input as well as for the combined (summed) seasonal and/or annual results from multiple groups of user-selected sources. The program calculations of concentration or deposition are performed for an input set of receptor coordinates defining a fixed receptor grid system and/or for discrete (arbitrarily placed) receptor points. The receptor grid system may be a right-handed Cartesian coordinate system or a polar coordinate system. In either case, zero degrees (north) is defined as the positive Y axis and ninety degrees (east) is defined as the positive X axis and all points are relative to a user-defined hypothetical origin (normally (X=0, Y=0), although the Universal Transverse Mercator (UTM) coordinates may be used as the Cartesian coordinate system).

Capabilities of the ISCLT program include:

- The capability to calculate either ground-level average concentration or total deposition
- The capability to process an unlimited number of sources
- The capability to model stacks, volume sources and area sources in the same execution
- The capability to specify source locations anywhere within or outside of the receptor grid system or discrete receptor points
- The capability to produce either seasonal or annual results or both
- The capability to display concentration or deposition from individual sources
- The capability to display combined (summed) concentration or deposition from multiple user-related subsets of the sources or from all sources
- The capability of saving the results of all calculations, the source data and the meteorological data on a master source/concentration (deposition) inventory magnetic tape or data file

- The capability of updating (adding to, modifying or deleting from) a master source/concentration (deposition) inventory magnetic tape or data file
- The capability to specify a regular receptor array or a set of discrete (arbitrarily placed) points or both
- The capability to specify a right-handed Cartesian coordinate system or a polar coordinate system for the regular receptor array or for the discrete (arbitrarily placed) receptors
- The capability to specify terrain elevations for each receptor and source for concentration calculations
- The capability to specify either an urban or a rural mode
- The capability of displaying the maximum 10 concentration or deposition values and their locations for each individual source and for the combined (summed) sources
- The capability of displaying the 10 values of concentration or deposition from each source that contributes to the maximum 10 for the combined (summed) sources
- The capability of letting the program determine the maximum 10 locations or letting the user specify a select group of 10 locations on a seasonal or annual basis
- The capability of using either seasonal or annual meteorological data

- The capability of specifying the number of wind speed, Pasquill stability and wind direction categories in the meteorological data

- The capability to vary source emissions by season, by Pasquill stability category and season, by wind speed category and season or by wind speed category, Pasquill stability category and season (season is defined as winter, spring, summer and fall or annual only)

The ISCLT computer program is written in FORTRAN, is designed for use on a UNIVAC 1110 computer and is compatible with both the UNIVAC FORTRAN V and ASCII compilers. However, the program is also designed to execute on most medium to large scale computers with minimal or no modifications. Program modifications necessary for computers other than the UNIVAC 1100 series computers are given below in Section 4.2.7. The program requires approximately 65,000 words (UNIVAC 1110) of executable core for instruction and data storage. The program design assumes a minimum of 32 bits per variable word and a minimum of four character bytes per computer word. The program also requires from two to four input/output devices, depending on whether the tape input/output options are used. Input card image data is referenced as logical unit 5 and print output, which requires 132-character print columns, is referenced as logical unit 6. The optional tape or data file input is referenced as logical unit 2 and the output is referenced as logical unit 3. The user has the option of either using the default logical unit numbers given here or specifying alternate logical unit numbers. The computer program consists of a main program (ISCLT) and 15 subroutines (MODEL, OUTPT, HEADNG, MXIMUM, CHECKR, SUMMER, TITLR, DISTR, FUNCT, VERTC1, VERTC2, VERTC3, SIGMAZ, VIRTZ and VIRTY). The FORTRAN source code for each of these routines is given in Appendix B and a logic flow description of the ISCLT program is given in Appendix I.

4.2.2 Control Language and Data Deck Setup

a. Control Language Requirements. The following illustrates the required ECL control statement runsteam for a typical run on a UNIVAC 1110 Operating System:

```
1.     @RUN,priority  jobid,account,userid,
                                  time,pages

                                                  } May be necessary with
2.     @PASSWD  user-password                     } batch runs, depending
                                                  } on system

3.     @ASG,A  prog-file.

4.     @ASG,T  input-tape-file.,16N,reel-number  } Optional, required
                                                  } only if ISW(5)=2 or
       @USE nn,input-tape-file.                   } 3 and data is on tape

                                                  } Optional, required
       @MOVE  input-tape-file.,ℓ                  } only if data is the
                                                  } ℓth file on tape, ℓ>1

       or

                                                  } Optional, required
       @ASG,A  input-file.                        } only if ISW(5)=2 or
       @USE nn,input-file.                        } 3 and data is on mass
                                                  } storage file

5.     @ASG,TF/W  output-tape-file.,16N,reel-    } Optional, required
                                         number   } only if ISW(5)=1 or
                                                  } 3 and data is output
       @USE mm,output-tape-file.                  } to tape

                                                  } Optional, required
       @MOVE  output-tape-file.,ℓ                 } only if data output
                                                  } file  ℓ  is greater
                                                  } than 1

       or
```

```
                                             Optional, required
                                             only if ISW(5)=1 or
         @ASG,CP  output-file.               3 and data is output
         @USE mm, output-file.               to a mass storage
                                             file to be catalogued
                                             and saved at the end
                                             of the run


         or
                                             Optional, required
                                             only if ISW(5)=1 or
                                             3 and data is output
         @ASG,T output file.                 to a temporary mass
         @USE mm,output-file.                storage file to be
                                             deleted at the end
                                             of the run

6.       @XQT  prog-file.ISCLT

7.       card-input-data

8.       @FIN
```

where

priority = job run priority

jobid = six-character user supplied job identification. May also specify core usage requirements, check with your system consultant

account = account number, assign by installation accounting

userid = six-character user identification code

time = execution time required

pages = maximum number of output pages

user-password = password, assigned by installation accounting

prog-file = is the name of the program file. This illustration assumes the user (installation) has assembled and collected (linked) the long-term program into this file and called the absolute program ISCLT.

input-tape-file = a user supplied file name used to reference the optional source/concentration (deposition) inventory input tape. This tape was created by a previous run of the ISCLT program.

reel-number = the physical tape reel-number assigned by the installation tape librarian. Each tape reel-number is unique.

nn = the FORTRAN logical unit number with which the ISCLT program is to reference (read) the input tape. This number is defined under the ISW(14) parameter input option and is always positive here.

ℓ = the number of file-marks to space over on the input tape to position the tape at the desired input data set. The MOVE card is only required if $\ell > 1$.

input-file = the name of a catalogued file containing the input source/concentration (deposition) inventory. This assignment assumes the file was created by a previous run of the ISCLT program.

output-tape-file = a user supplied file name used to reference the optional source/concentration (deposition) inventory output tape.

mm = the FORTRAN logical unit number with which the ISCLT program is to reference (write) the output tape. This number is defined under the ISW(15) parameter input option and is always positive here.

output-file = the name of a catalogued or temporary file to which the output source/concentration (deposition) inventory is to be written.

card-input-data = that card deck consisting of all necessary data cards defined in Section 4.1.2 above and shown in Figure 4-1, Section 4.2.2.b.

The JCL control statement runstream for a typical run on an IBM 360 Operating System is given below:

```
1.        //jobid  JOB(account),'name',Time=time
```

```
2.        //JOBLIB  DD  DSNAME=prog-file,DISP=(OLD,PASS)

3.        //STEP1  EXEC  PGM=ISCLT

4.        //FT05F001  DD  DDNAME=SYSIN

5.        //FT06F001  DD  SYSOUT=A

6.        //FTnnF001  DD DSN=input-tape-file,UNIT=TAPE,VOL=SER=reel-number,
                                                 DCB=RECFM=V,DISP=OLD

7.        //FTmmF001  DD  DSN=output-tape-file,UNIT=TAPE,VOL=SER=reel-number,
                                             DCB=RECFM=V,DISP=(NEW,KEEP)

8.        //GO.SYSIN  DD  *

9.        card-input-data

10.       /*
```

where the lower case names and letters are defined the same as under the UNIVAC ECL definitions. This illustration assumes the user has assembled the ISCLT program into an absolute deck located in a catalogued library "prog-file" and that the absolute deck is called ISCLT. Also, cards 6 and 7 are optional input and output tapes.

The control statement runstream for a typical run on a CDC 6500 Operating System is given by:

```
1.        job-card(s)

2.        REQUEST,TAPEnn,VRN=reel-number,HY - Optional input tape

3.        REQUEST,TAPEmm,VRN=reel-number,RW,HY - Optional output tape
```

4. ATTACH,ISCLT,prog-file [,options]

5. ZRO.

6. ISCLT.

7. $\left.\begin{matrix}7\\8\\9\end{matrix}\right\}$ Card Column One

8. card-input-data

9. $\left.\begin{matrix}6\\7\\8\\9\end{matrix}\right\}$ Card Column One

where

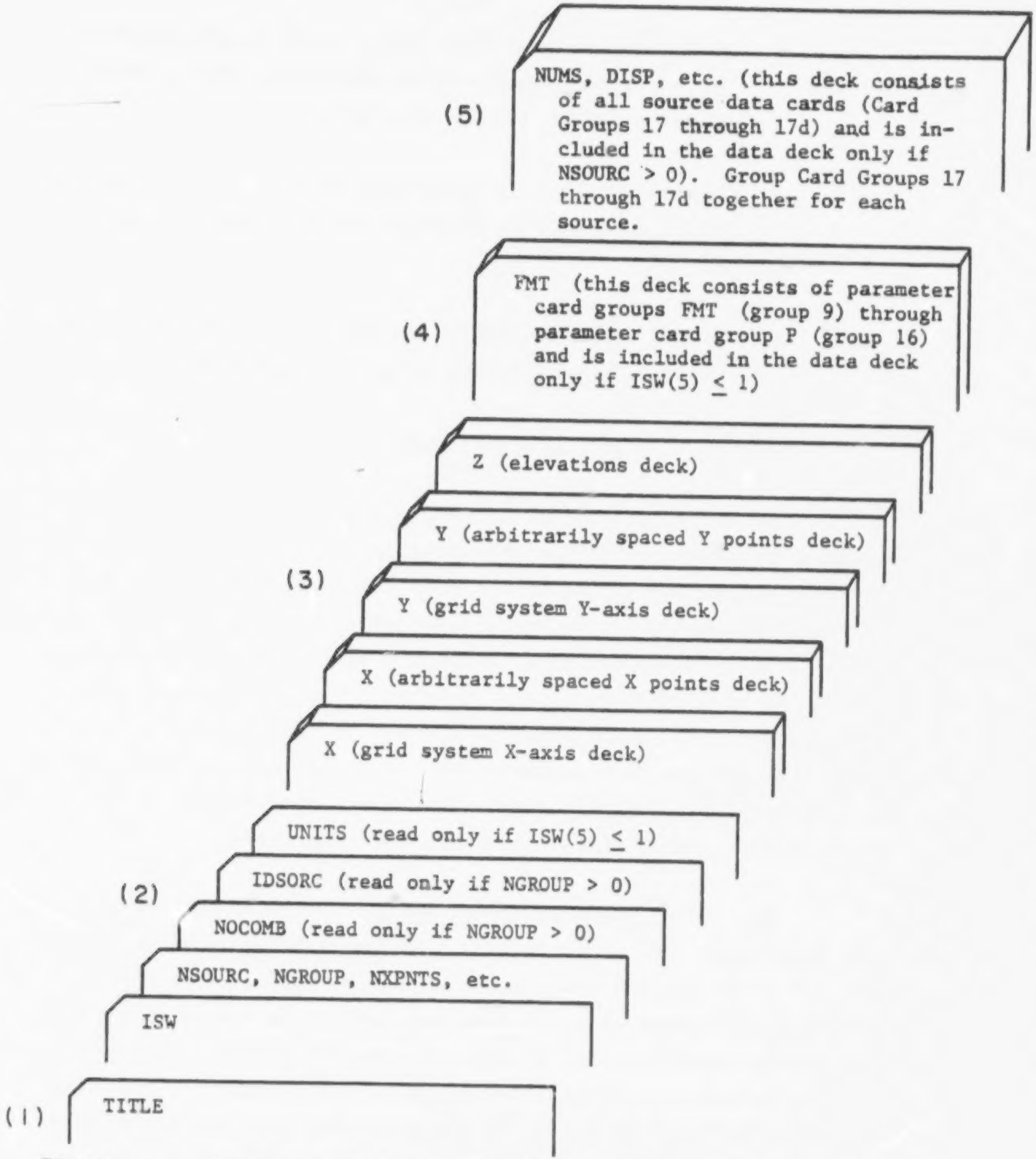
job-card(s) = job card or cards that consist of the job name, account, password, etc. depending on the installation.

The remaining lower case names and letters are defined the same as under the UNIVAC ECL definitions. The illustration assumes the user has assembled the ISCLT program into an absolute deck located in a catalogued file "prog-file" and that the absolute deck, which is called ISCLT, is used as the LGO (load and go) file.

b. Data Deck Setup. The card input data required by the ISCLT program depends on the program options desired by the user. The card input deck may be partitioned into five major groups of card data. Figure 4-1 illustrates the input deck setup. The five major input deck groups are:

1. Title Card (1 data card)

2. Program Option and Control Cards (2 to 5 data cards)



NUMS, DISP, etc. (this deck consists of all source data cards (Card Groups 17 through 17d) and is included in the data deck only if NSOURC > 0). Group Card Groups 17 through 17d together for each source.

FMT (this deck consists of parameter card groups FMT (group 9) through parameter card group P (group 16) and is included in the data deck only if ISW(5) $\leq$ 1)

Z (elevations deck)

Y (arbitrarily spaced Y points deck)

Y (grid system Y-axis deck)

X (arbitrarily spaced X points deck)

X (grid system X-axis deck)

UNITS (read only if ISW(5) $\leq$ 1)

IDSORC (read only if NGROUP > 0)

NOCOMB (read only if NGROUP > 0)

NSOURC, NGROUP, NXPNTS, etc.

ISW

TITLE

FIGURE 4-1. Input data deck setup for the ISCLT program.

3. Receptor Data Cards (the number of data cards included in this group depends on the parameters ISW(4), ISW(5), ISW(12), NXPNTS, NYPNTS and NXWYPT)

4. Meteorological Data Cards (this card deck is included in the input deck only if ISW(5) is less than or equal to "1")

5. Source Data Cards (this card deck is included in the input deck only if NSOURC is greater than zero)

4.2.3 Input Data Description

Section 4.1.2 provides a summary description of all input data parameter requirements for the ISCLT program. This section provides the user with the FORTRAN format and order in which the program requires the input data parameters. The input parameter names used in this section are the same as those introduced in Section 4.1.2. Two forms of input data may be input to the program. One form is card image input data (80 characters per record) in which all required input data may be entered. The other form is magnetic tape or mass storage on which some of the required input data was stored as part of a previous run of the ISCLT program. Both forms of input are discussed below.

a. Card Input Requirements. The ISCLT program reads all card image input data in a fixed-field format with the use of a FORTRAN "A", "I" or "F" editing code (format). Each parameter value must be punched in a fixed-field on the data card defined by the start and end card columns specified for the variable. Table 4-4 identifies each variable by name and respective card group. Also, Table 4-4 specifies the card columns (fixed-field) for the parameter value and the editing code ("A", "I" or "F") used to interpret the parameter value. Parameters using an "A" editing code are alpha-numeric data items used primarily for

TABLE 4-4

ISCLT PROGRAM CARD INPUT PARAMETERS, FORMAT AND DESCRIPTION

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
1	TITLE	1 - 80	20A4	80 character page heading label
2	ISW(1)*	2	I1	blank, 0 or 1 = calculate concentration 2 = calculate deposition
	ISW(2)*	4	I1	blank, 0 or 1 = Cartesian coordinate receptor grid system 2 = Polar coordinate receptor grid system
	ISW(3)*	6	I1	blank, 0 or 1 = Cartesian discrete (arbitrarily placed) receptors 2 = Polar discrete receptors
	ISW(4)*	8	I1	blank or 0 = no terrain elevation data 1 = terrain elevation data
	ISW(5)	10	I1	blank or 0 = no input or output tape 1 = output tape only 2 = input tape only 3 = both input and output tapes

*These parameters are set automatically by the program and cannot be changed if tape input ISW(5) = 2 or 3) is being used.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2 (Cont.)	ISW(6)	12	I1	blank or 0 = input data are not printed 1 = print all but source input data 2 = print source input data only 3 = print all input data
	ISW(7)	14	I1	1 = print seasonal (monthly) calculations only 2 = print annual calculations only blank, 0 or 3 = print both seasonal and annual calculations
	ISW(8)	16	I1	1 = print only concentration (deposition) from individual sources 2 = print only concentration (deposition) from combined sources blank, 0 or 3 = print concentration (deposition) from both individual and combined sources
	ISW(9)	18	I1	1 = Urban Mode 1 2 = Urban Mode 2 blank, 0 or 3 = Rural Mode if ISW(5) = 0 or 1 blank or 0 = Value from input tape if ISW(5) = 2 or 3
	ISW(10)	20	I1	blank or 0 = maximum 10 concentration (deposition) values are not calculated 1 = maximum 10 concentration (deposition) values are calculated according to ISW (11) or ISW(12) and only these calculations are printed

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2 (Cont.)	ISW(10) (Cont.)			2 = maximum 10 concentration (deposition) values are calculated according to ISW(11) or ISW(12) and these as well as the concentration (deposition) values at all other receptors are printed
	ISW(11)	22	I1	blank or 0 = see ISW(12) if ISW(10) > 0 1 = program determines maximum 10 of each individual source and source combination independently of each other 2 = program determines maximum 10 of combined sources and prints those as well as the contributions of each individual source to those receptors
	ISW(12)	24	I1	blank or 0 = see ISW(11) if ISW(10) > 0 1 = user specifies maximum 10 or special 10 receptors
	ISW(13)	25 - 26	I2	blank or 0 = print output goes to FORTRAN logical unit 6 (printer) n > 0 = print output goes to FORTRAN logical unit n followed by two end-of-file marks n < 0 = print output goes to FORTRAN logical unit n with no end-of-file marks
	ISW(14)	27 - 28	I2	blank or 0 = tape input data is read from FORTRAN logical unit 2 n > 0 = input data is read from magnetic tape on FORTRAN logical unit n n < 0 = input data is read from mass-storage on FORTRAN logical unit n

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
2 (Cont.)	ISW(15)	29 - 30	I2	blank or 0 = tape output data is written to FORTRAN logical unit 3 (magnetic tape) n > 0 = output data is written to magnetic tape on FORTRAN logical unit n n < 0 = output data is written to mass storage on FORTRAN logical unit n
	ISW(16)	32	I1	blank or 0 = each new output table starts on a new page 1 = program minimizes number of output pages by not starting a new page even though successive tables are not related.
	ISW(17)	33 - 34	I2	blank or 0 = the program prints 57 lines per page before ejecting to a new page n > 0 = the program prints n lines per page before ejecting to a new page
	ISW(18)	35 - 36	I2	blank or 0 = the program reads Card Group 9a using a 6F10.0 format 1 = the program reads Card Group 9 which specifies the format the program is to use to read Card Group 9a
	ISW(19)	38	I1	blank or 0 = plume rise is independent of downwind distances 1 = plume rise is dependent on downwind distance
	ISW(20)	40	I1	blank or 0 = no stack-tip downwash correction is made at the stack height 1 = the Briggs (1973) downwash correction is applied to the stack height

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
3	NSOURC	1 - 4	I4	Number of card image input sources to be read under Card Group 17 to 17d below. If negative the program will continue to read Card Group 17 to 17d until a negative source ID-number is read from Card Group 17.
	NGROUP	5 - 8	I4	Number of different source combinations used to print concentration (deposition) calculations (the maximum is 20). If set to zero Card Groups 4 and 4a are omitted from the input card deck.
	NXPNTS*	9 - 12	I4	Number of receptors in the X-axis of the receptor grid system. (The number of rings in polar coordinates.)
	NYPNTS*	13 - 16	I4	Number of receptors in the Y-axis of the receptor grid system. (The number of radials in polar coordinates.)
	NXWYPT	17 - 20	I4	Number of discrete (arbitrarily placed) receptor points. This parameter is not used if ISW(5) = 2 or 3 unless ISW(12) is non-zero.
	NSEASN*	21 - 24	I4	Number of seasons (months) in the input meteorological data. The maximum for this parameter is 4 and if blank or 0 the default is 1.

*These parameters are set automatically by the program and cannot be changed if tape input (ISW(5) = 2 or 3) is being used.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
3 (Cont.)	NSPEED*	25 - 28	I4	Number of wind speed categories in the joint frequency of occurrence of wind speed and direction. The maximum is 6 and 6 is the default value if blank or 0.
	NSTBLE*	29 - 32	I4	Number of Pasquill stability categories in the joint frequency of occurrence of wind speed and direction. The maximum is 6 and the default is 6 if blank or 0.
	NSCTOR*	33 - 36	I4	Number of wind direction sector categories in the joint frequency of occurrence of wind speed and direction. The maximum is 16 and the default is 16 if blank or 0.
	NOFILE	37 - 40	I4	Output file number of output tape or if no output tape, then input file number of input tape. Applicable to magnetic tape only, when Condition a or Condition b is being used under ISW(11) or NGROUP.

*These parameters are set automatically by the program and cannot be changed if tape input (ISW(5) = 2 or 3) is being used.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
4	NOCOMB	1 - 4 5 - 8 : 77 - 80	20I4	Array used to specify the number of source ID-numbers you are using to define each source combination. There are NGROUP values read here. This data card is omitted from the input card deck if NGROUP = 0.
4a	IDSORC	1 - 6 7 - 12 : 73 - 78 (for each card)	13I6	Array used to specify the source ID-numbers to use in forming the combined source output and individual source output. There is a maximum of 200 values that can be input here. This data card group is omitted from the input card deck if NGROUP = 0.
5**	UNITS	1 - 40	10A4	40 characters giving the concentration (deposition) print output units. This label is automatically filled if the parameter TK on Card Group 13 is defaulted. If this label is punched, start in column 1.
		41 - 80	10A4	40 characters giving the source strength input units. This label is automatically filled if the parameter TK on Card Group 13 is defaulted. If this label is punched, start in column 41. This card group is omitted from the input deck if tape input (ISW(5) = 2 or 3) is being used.

**These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
6**	X	1 - 10 11 - 20 . . . 71 - 80 (for each card)	8F10.0	Array of NXPNTS receptor points in meters in ascending order defining the X-axis of the receptor grid system or the distances to the rings in polar coordinates. If only two values are punched and NXPNTS is greater than 2, the program assumes the first is the start of the axis and the second is the increment it uses to generate the remaining points. This card group is omitted from the input data deck if NXPNTS = 0.
6a	X	1 - 10 11 - 20 . . . 71 - 80 (for each card)	8F10.0	Array of NXWYPT discrete receptor points in meters. This card group is omitted from the input data deck if NXWYPT = 0 or if an input tape is being used and ISW(12) = 0.
7**	Y	1 - 10 11 - 20 . . . 71 - 80 (for each card)	8F10.0	Array of NYPNTS receptor points in meters or degrees, depending on ISW(2), in ascending order defining the Y-axis of the receptor grid system or the radials in polar coordinates. If only two values are punched and NYPNTS is greater than 2, the program assumes the first is the start of the axis and the second is the increment used to generate the remaining points. This card group is omitted from the input data deck if NYPNTS = 0.

**These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
7a	Y	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of NXWYPT discrete receptor points in meters or degrees depending on ISW(3). This card group is omitted from the input data deck if NXWYPT = 0 or if an input tape is being used and ISW(12) = 0.
8**	Z	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of terrain elevations in **feet** for each receptor of the NXPNTS by NYPNTS grid system. This card group is omitted from the input data deck if either ISW(4) = 0 or an input tape is being used. See the text for the order of values input to this card group.
8a	Z	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of terrain elevations in **feet** for each discrete receptor. This card group is omitted from the input card deck if ISW(4) = 0 or NXWYPT = 0 or an input tape is being used and ISW(12) = 0.

** These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
9**	FMT	1 - 80	20A4	Array specifying the format used to read Card Group 9a (not read if ISW(18)= 0, default format is 6F10.0)
9a**	FREQ	1 - 10*** 11 - 20 : 51 - 60 (for each card)	FMT	Array giving the joint frequency of occurrence of the wind speed and direction for each stability category and each season expressed as a percentage or as a fraction. See the text for the order of input values.
10**	TA	1 - 10 11 - 20 : 51 - 60 (for each card)	6F10.0	Array of ambient air temperatures in degrees Kelvin as a function of stability category and season. See the text for the order of input values.
11**	HM	1 - 10 11 - 20 : 51 - 60 (for each card)	6F10.0	Array of mixing layer heights in meters as a function of wind speed and stability category and season. See the text for the order of input values.

**These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

***These are the default card columns used for this array and are not applicable if FMT on Card Group 9 is input.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
12**	DPDZ	1 - 10 11 - 20 ⋮ 51 - 60 (for each card)	6F10.0	Array of the vertical gradient of potential temperature in degrees Kelvin per meter as a function of wind speed and stability category. See the text for the order of input values.
13**	ROTATE	1 - 10	F10.0	Wind direction correction parameter used to correct for any difference in north as defined by the reference receptor grid system and north as defined by the weather station at which the weather data were recorded. The value of ROTATE is subtracted from each wind direction category.
	TK	11 - 20	F10.0	Model units conversion factor used to produce the desired output concentration (deposition) units from the input source strength units. The concentration default for TK is 1 x 10^6 micrograms per gram assuming output in micrograms per cubic meter and input source units in grams per second for stack and volume sources and grams per second per square meter for area sources. The deposition default for TK is 1 assuming output in grams per square meter and input source units in total grams for stack and volume sources and grams per square meter for area sources.

**These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
13 ** (Cont.)	TK (Cont.)			If the default is chosen, the parameter UNITS above on Card Group 5 is automatically set.
	ZR	21 - 30	F10.0	Height in meters above ground at airport or weather station at which the wind speed was measured. The default value is 10.0 meters.
	BETA1	31 - 40	F10.0	Air entrainment coefficient for an adiabatic or unstable atmosphere. The default is 0.6.
	BETA2	41 - 50	F10.0	Air entrainment coefficient for a stable atmosphere. The default is 0.6.
	G	51 - 60	F10.0	Acceleration due to gravity in meters per second squared. The default is 9.8 m/sec^2.
	DECAY	61 - 70	F10.0	Coefficient (seconds^{-1}) of time dependent pollutant removal by physical or chemical processes. Default is zero or no decay.
14 **	UBAR	1 - 10 11 - 20 ⋮ 51 - 60	6F10.0	Array containing the median value of each wind speed category in meters per second. The default values are 0.75, 2.5, 4.3, 6.8, 9.5 and 12.5 m/sec for the standard STAR summary wind-speed categories.

** These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
15 **	THETA	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of wind direction sector angles in degrees beginning with the first direction category used in the joint frequency of occurrence of wind speed and direction (normally zero degrees north). NSCTOR values are read and,if the first two values are zero this array is defaulted to the standard direction angles 0.0, 22.5, 45.0, . . ., 337.5 degrees.
16 **	P	1 - 10 11 - 20 ⋮ 51 - 60 (for each card)	6F10.0	Array of wind speed power law exponents as a function of wind speed and stability categories. See the text for the order of values and default values.
17	NUMS	1 - 5	I5	Source identification number. Input all sources in ascending order of the identification number. If the number is negative, source input is terminated. If this number is zero, the program defaults the relative position of this source in the source input deck. Card Groups 17 through 17d are omitted from the input data deck if NSOURC equals zero. Remember to group Card Groups 17 through 17d together as a set for each input source.

** These card groups are omitted from the input card deck if tape input (ISW(5) = 2 or 3) is being used. The information for these parameters is taken from the input tape.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
17 (Cont.)	DISP	6	I1	Source disposition. blank or 0 = new input source or replace old source if it has same ID-number 1 = delete incoming tape source with same ID-number (next card group read is 17) 2 = rescale concentration (deposition) values for this source using input source strengths (next card group read is 17d) (only if QFLG = 0)
	TYPE	7	I1	Source type. blank or 0 = stack 1 = volume 2 = area
	QFLG	8	I1	Source emissions variation flag. blank or 0 = source emission varies with season (month) only 1 = source emission varies with stability category and season 2 = source emission varies with wind speed category and season 3 = source emission varies with wind speed and stability category and season
	DX	9 - 18	F10.0	Cartesian X-coordinate of the source in meters. (source center for building and stack sources and southwest corner for area sources)
	DY	19 - 28	F10.0	Cartesian Y-coordinate of the source in meters. (source center for building and stack sources and southwest corner for area sources)
	H	29 - 35	F7.0	Height above the ground of the emission in meters

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
17 (Cont.)	ZS	36 - 42	F7.0	Elevation in meters above mean sea level at the source location.
	TS or SIGYO or XO	43 - 49	F7.0	This field depends on the source type -- if TYPE = 0, TS = stack gas exit temperature in degrees Kelvin TYPE = 1, SIGYO = standard deviation of the cross-wind source distribution in meters TYPE = 2, XO = width of the area source in meters
	VEL or SIGZO	50 - 56	F7.0	This field depends on the source type -- if TYPE = 0, VEL = stack gas exit velocity in meters per second TYPE = 1, SIGZO = standard deviation of the vertical source distribution in meters TYPE = 2, this field is left blank
	D	57 - 63	F7.0	This field depends on the source type -- if TYPE = 0, D = inner stack diameter in meters TYPE = 1 or 2, this field is left blank
	HB	64 - 70	F7.0	This field depends on the source type -- if TYPE = 0, HB = 0, Wake effects are not considered for this source HB > 0, height above ground in meters of the building adjacent to the stack for the consideration of wake effects for this source TYPE = 1 or 2, this field is left blank

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
17 (Cont.)	BW	71 - 77	F7.0	This field depends on the source type -- if TYPE = 0, BW = 0, wake effects are not considered for this source BW > 0, width of the building in meters adjacent to the stack for the consideration of wake effects for this source TYPE = 1 or 2, this field is left blank
	WAKE	78	11	This field depends on the source type -- if TYPE = 0, WAKE is a super squat building wake effects equation option. If the building width to height ratio is greater than 5 and WAKE is blank, or 0, the program uses the equation of lateral virtual distance (Equation (2-31) that will produce the upper bound of concentration or deposition. If WAKE is 1, the equation of lateral virtual distance (Equation (2-33)) that will produce the lower bound of the concentration or deposition calculation is used (see Section 2.4.1.1.d) TYPE 1 or 2, this field is left blank
	NVS	79 - 80	I2	Number of particulate size categories in the particulate distribution for deposition or concentration with depletion due to dry deposition. The maximum value of this parameter is 20.

TABLE 4-4 (Continued)

Card Group	Parameter Name	Card Columns	FORTRAN Edit Code (Format)	Description
17a	VS	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of settling velocities in meters per second for each particulate size category. This card group is omitted from the input data deck if NVS = 0.
17b	FRQ	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of mass fraction of the particulate distribution for each category. The sum of the fractions in this array should total 1 (100% of the distribution). This card group is omitted from the input data deck if NVS = 0.
17c	GAMMA	1 - 10 11 - 20 ⋮ 71 - 80 (for each card)	8F10.0	Array of surface reflection coefficients (fraction, 0 to 1) for each particulate size category. A value of 0 is no reflection; a value of 1 is complete reflection. This card group is omitted from the data deck if NVS = 0.
17d	Q	1 - 10 11 - 20 ⋮ 51 - 60 (for each card)	6F10.0	Array of source emissions in units indicated by the parameters UNITS and TK above. The number of values input in this card group is determined by QFLG on Card Group 17 and the order of input is given in the text. This card group is omitted from the input data deck if DISP on Card Group 17 equals "1".

labeling purposes. These data items can be punched anywhere in the specified data columns and can consist of any character information. If not punched, these data items are interpreted as blanks. Parameters using an "I" editing code are integer (whole number) data items. These data items must be numeric punches only and must be punched (right justified) so the units digit of the number is in the right most column of the field. If the punch field for the variable is not punched (left blank), it is interpreted as zero. Parameters using an "F" editing code are real number data items. These data items can be punched like integer ("I") data items (right justified) if they are whole numbers. However, they must be punched with a decimal point (".") if they contain a fractional part.

Card Group 1 in Table 4-4 gives the print output page heading and is always included in the input data deck. Any information to identify the output listing or data case may be punched into this card. If the card is left blank, the heading will consist of only the output page number or the heading will be taken from the input tape or data file, if used.

Card Group 2 gives the values of the program option array ISW. This card is always included in the input data deck. However, the values of ISW(1) through ISW(4) are automatically set by the program if you are using an input (source/concentration or deposition inventory) tape. The options on this card that determine whether or not some card groups are included in the input data deck are: ISW(4), ISW(5), ISW(12) and ISW(18). If ISW(4) is left blank or punched zero, Card Groups 8 and 8a are omitted from the input data deck. If ISW(5) is equal to "2" or "3" (indicating an input data tape), Card Groups 5, 6, 7, 8 and 9 through 16 are omitted from the input data deck. Also, Card Groups 6a 7a, and 8a are omitted if the ISW(12) option is not used or equals blank or zero. If ISW(18) is left blank or punched zero, Card Group 9 is omitted from the input card deck. The ISW(10) option on this card must be set to "1" or "2" if either the ISW(11) or ISW(12) option is chosen. Also, if the ISW(11) option equals "2", one or more of the following conditions must be met:

Condition a -- The run uses an output tape or data file. This tape or file may be a permanent catalogued file or may be temporary, lasting only for the duration of the run. If this condition is selected and the output medium is tape, the parameter NOFILE on Card Group 3 must be input.

Condition b -- The run uses an input tape or catalogued data file, but has no input data card sources (NSOURC equals zero). If this condition is selected and the input medium is tape, the parameter NOFILE on Card Group 3 must be input.

Condition c — The total number of non-deleted input sources from data card and tape (data file) is less than or equal to the minimum of I and J, where:

$$\left.\begin{array}{l} J = 300 \\ \text{and} \\ I = \left[\dfrac{E - (NXPNTS+NYPNTS+2*NXWYPT) - K - L}{NSEASN*(NXPNTS*NYPNTS+NXWYPT)}\right] \end{array}\right\} \qquad (4\text{-}4)$$

E = the total amount of program data storage in BLANK COMMON. The program design size is 40,000.

$$K = \mathrm{NSEASN}*(\mathrm{NXPNTS}*\mathrm{NYPNTS}+\mathrm{NXWYPT})$$

$$L = \begin{cases} 0 & ;\ \text{if } \mathrm{ISW}(4) = 0 \\ \mathrm{NXPNTS}*\mathrm{NYPNTS}+\mathrm{NXWYPT}; & \text{if } \mathrm{ISW}(4) = 1 \end{cases}$$

the remaining variables are input parameters defined on Card Group 3.

Also, the option ISW(9) must always be set correctly when card input sources are used or if tape sources are used when ISW(12) equals "1".

Card Group 3 contains the parameters that specify the number of input card sources, size of receptor arrays and the number of categories in the input meteorological data. These parameters are regarded as options because, if any are zero, a particular function is not performed. *All of the parameters on this card except NOFILE may alter the form of the input deck* because they specify how may data items to input to the program. The parameter NSOURC specifies how many data card sources to input or how many times the program is to read Card Groups 17 through 17d. If NSOURC is set to a negative value ("-1"), the program will continue to read source data from Card Groups 17 through 17d until a negative source ID-number (NUMS) is read from Card Group 17. If NSOURC is zero, Card Groups 17 through 17d are omitted from the input data deck. The parameter NGROUP is used to group selected sources into a combined output by summing the concentration or deposition arrays of the selected sources. The user may specify up to a maximum of 20 different source combinations. If NGROUP is left blank or punched zero, the program uses all sources in any combined source output, prints all sources for any individual source output, and Card Groups 4 and 4a are omitted from the input card deck. If NGROUP is greater than zero, it specifies how may values are to be read from Card Groups 4 and 4a. Also

NGROUP cannot be set to a non-zero value unless one or more of the following conditions is met:

Condition a -- The run uses an output tape or data file. This tape or file may be a permanent catalogued file or may be temporary, lasting only for the duration of the run. If this condition is selected and the output medium is tape, the parameter NOFILE on this card group must be input.

Condition b -- The run uses an input tape or data file, but no input card sources (NSOURC equals zero). If this condition is selected and the input medium is tape, the parameter NOFILE on this card group must be input.

Condition c — The total number of input card and tape sources is less than or equal to the minimum of I and J where:

$$\left.\begin{aligned} J &= 300 \\ &\text{and} \\ I &= \frac{E - (\text{NXPNTS}+\text{NYPNTS}+2*\text{NXWYPT}) - K - L}{\text{NSEASN}*(\text{NXPNTS}*\text{NYPNTS}+\text{NXWYPT})} \end{aligned}\right\} \quad (4\text{-}5)$$

E = the total amount of program data storage in BLANK COMMON. The program design size is 40,000.

$$K = \begin{cases} 0 & ; \quad \text{if ISW(8)=1 and ISW(11)} \neq 2 \\ \text{NSEASN}*(\text{NXPNTS}*\text{NYPNTS}+\text{NXWYPT}); & \quad \text{if ISW(8)} \neq 1 \text{ or ISW(11)=2} \end{cases}$$

$$L = \begin{cases} 0 & ;\ \text{if ISW(4) = 0} \\ \text{NXPNTS*NYPNTS+NXWYPT;} & \text{if ISW(4) = 1} \end{cases}$$

The parameters NXPNTS, NYPNTS and NXWYPT define the size of the program receptor point arrays. The maximum values of these parameters are limited by the core-use equation (4-3) given under NXPNTS in Section 4.1.2. If an input tape is being used, these parameters are normally ignored by the program because these values are taken from the input tape. However, if the ISW(12) option is selected, the parameter NXWYPT must be set to a multiple of 10 as outlined in Section 4.1.2. When ISW(12) is choosen and an input tape is being used, the original receptor points from the incoming tape are destroyed and replaced by a new set of discrete (arbitrarily placed) points indicated by NXWYPT. This necessitates a new set of calculations for the special points and requires ISW(9) to be set correctly. An output tape produced under these conditions contains only the calculations for the discrete receptors. The parameters NSEASN, NSPEED, NSTBLE and NSCTOR specify the number of seasons (NSEASN), the number of wind speed categories (NSPEED), the number of stability categories (NSTBLE) and the number of wind direction categories (NSCTOR) in the input meteorological data. These parameters are set automatically by the program when an input tape is being used. The parameter NOFILE must be specified if the user is using input and/or output tape and is applying Condition a or Condition b given under ISW(11) and/or NGROUP. This parameter is the output file number of the file to be written to tape (ISW(5) = "1" or "3") or the input tape file number, if no output file is geing generated (ISW(5) = "2"). The program uses this parameter to correctly position the tape if additional passes through the tape data are required.

Card Groups 4 and 4a always occur together and are included in the input card deck only if NGROUP is greater than zero. Card Group 4 is the array NOCOMB used to specify the number of source ID-numbers used to define each source combination. Each value in NOCOMB specifies the number of source ID-numbers to be read from Card Group 4a (IDSORC) in consecutive order for each source combination. A positive source ID-number punched into the array IDSORC indicates to include that source in the combination. A negative source ID-number indicates to include that source as well as all source ID-numbers less in absolute value, up to and including the previous positive source ID-number punched if it is part of the same set of ID-numbers defining a combination. If the negative value is the first ID-number of a group of ID-numbers, it as well as all sources less in absolute values of ID-number are included in the source combination. See the example given under NOCOMB and IDSORC in Section 4.1.2 and the example problems in Appendix D. The data values are read from Card Group 4 using 4 card columns per value with a maximum of 20 values and from Card Group 4a using 6 card columns per value, 13 values per card with a maximum of 200 values or 16 data cards.

Card Group 5 is an array (UNITS) used to specify the labels printed for concentration or deposition output units and for the input source strength units. This card group is omitted from the input card deck if tape or data file input is used.

Card Groups 6 through 8a specify the X, Y and Z coordinates of all receptor points. Card Groups 6, 7 and 8 are omitted from the input card deck if the parameters NXPNTS and NYPNTS equal zero or if an input tape is being used. Also, Card Group 8 is omitted if ISW(4) equals "0" or no terrain elevations are being used. Card Groups 6a, 7a and 8a are also omitted from the input card deck if the parameter NXWYPT is zero or if an input tape is being used with ISW(12) equal to "0". Card Group 8a is also omitted if ISW(4) equals "0". Each of these card groups uses a 10 column field for each receptor value and 8 values per data card. The number of data cards required for each card group is defined by the values of the parameters NXPNTS, NYPNTS and NXWYPT. Values input on Card Groups 6 and 7 are always in ascending order (west to east, south to north, 0 to 360 degrees). The terrain elevations for the grid system on Card Group 8 begin in the southwest corner of the grid system or at 0 degrees for polar coordinates. The first data card(s) contain the elevations for each receptor on the X axis (1 to NXPNTS) for the first Y receptor coordinate. A new data card is started for the elevations for each successive Y receptor coordinate. A total of NYPNTS groups of data cards containing NXPNTS values each is required for Card Group 8. The elevations for the discrete receptors in Card Group 8a are punched across the card for as many cards as required to satisfy NXWYPT elevation values. See the discussion given for parameter Z in Section 4.1.2.b for examples of the order of input for receptor elevations in Cartesian and polar systems.

Card Groups 9 through 16 specify the meteorological data and model constants and are included in the input data deck only if an input tape or data file is not being used. Card Group 9 is input only if ISW(18) equals "1" and specifies the format (FMT) which the program uses to read the card data in Card Group 9a. If Card Group 9 is omitted from the input deck (ISW(18) equals "0"), the program assumes the format is (6F10.0) or there are 6 values per card occupying 10 columns each including the decimal point (period). Card Group 9a is the set of data cards giving the joint frequency of occurrence of the wind speed and wind direction (FREQ) by season and Pasquill stability category. The values for each wind speed category (1 to NSPEED) are punched across the card and are read using the format given in Card Group 9 or the default format used when Card Group 9 is omitted. The first card is for direction category 1 (normally north), the second card for direction category 2 (normally north-northeast), down to the last direction category (normally north-northwest). Starting with season 1 (normally winter), the card group contains a set of these (NSCTOR) cards for each stability category, 1 through NSTBLE. The program requires NSCTOR*NSTBLE*NSEASN data cards in this card group. This data deck is normally produced by the STAR program of the National Climatic Center (NCC). Card Group 10 is the average ambient air temperature (TA). NSTBLE values are read from each data card in this group and there is one data card for each season, 1 through NSEASN. Card Group 11 is the median mixing layer height (HM) for each speed and stability category and season. The program requires NSPEED values per data card and one data card for each stability category, 1 to NSTBLE. A group of these cards is required for each season (1 to NSEASN) for a total of NSTBLE*NSEASN data cards in Card Group 11. Card Group 12 is the vertical gradient of potential temperature (DPDZ) for each wind speed and stability category. NSPEED values are punched across the card and NSTBLE cards (1 to NSTBLE) are punched for this group. Card Group 13 contains meteorological and model constants; a detailed description of these parameters (ROTATE, TK, ZR, BETA1, BETA2, G and DECAY) is given in Section 4.1.2 above. Card Group 14 is the median wind speed for each wind speed category (UBAR) and there are NSPEED values read from this card group. Card Group 15 is the median wind direction for each wind direction category (THETA). There are 8 values read from each data card in this group up to a maximum of NSCTOR (normally 16) values. Card Group 16, the last of the meteorological input card groups, provides the wind speed power law exponents (P) for each wind speed and stability category. There are NSPEED values read per data card and NSTBLE (1 to NSTBLE) cards read in this group.

The last card groups in the input data deck, Card Groups 17 through 17d, consist of source related information. Card Groups 17 through 17d are always input as a set of cards for each individual source and each of these sets (17 through 17d) are input in ascending order of the source ID-number (NUMS). Card Group 17 provides the source

ID-number (NUMS), the source type (TYPE) the source disposition (DISP), etc. This data card is included in the input card deck for each card input source, 1 to NSOURC. As shown in Table 4-4, some of the card columns (43 through 78) on this card may or may not contain parameter values, depending on the source type. The last parameter (NVS) on this card determines whether Card Groups 17a through 17c are read or not. These card groups are not included in the input card deck if NVS equals zero. The last card group, Card Group 17d, contains the source emissions (Q). This card group is not included in the input deck if the parameter DISP on Card Group 17 equals "1". The number of cards and values in this card group depends on the parameter QFLG on Card Group 17. If QFLG equals blank or zero, the source emissions are a function of season only and one data card is read with NSEASN values punched across it. If QFLG is equal to "1", the program assumes the source emissions are a function of stability category and season. In this case, NSEASN data cards (1 through NSEASN) are required with NSTBLE values per card. If QFLG is equal to "2", the program assumes the source emissions are a function of wind speed and season. There are NSEASN data cards read with NSPEED values per card. If QFLG is equal to "3", the program assumes the source emissions are a function of wind speed, stability and season. In this last case, the program reads NSTBLE data cards containing NSPEED values for each season (1 to NSEASN) for a total of NSTBLE*NSEASN data cards. The program continues to read sets of data Card Groups 17 through 17d until a negative source ID-number is encountered or until it has read these cards NSOURC times.

b. Tape Input Requirements. The ISCLT program accepts an input source/concentration (deposition) inventory tape (catalogued data file) previously created by the ISCLT program. This tape is a binary tape written using the FORTRAN I/O routines and created as an output tape on a previous run of the ISCLT program. This tape contains all of the program options that affect how the model concentration or deposition calculations were performed (except ISW(9)), all of the receptor and elevation data, all of the meteorological data, all of the source input data and the results of the seasonal (annual) concentration or deposition calculations at each receptor point. The program reads the data from the FORTRAN logical unit number specified by ISW(14). The tape data are read only if option ISW(5) equals "2" or "3". *The input tape requires the user to omit specified data card groups from the input deck and makes the input of some parameter values unnecessary.* The omitted Card Groups and unnecessary parameters are indicated by a * or ** in the Card Group and Parameter Name columns of Table 4-4. The format and exact contents of the input tape are discussed in Section 4.2.4.b below.

4.2.4 Program Output Data Description

The ISCLT program generates several categories of printed output and an optional output source/concentration or deposition inventory tape or data file. The following paragraphs describe the format and content of both forms of program output.

a. Printed Output. The ISCLT program generates 11 categories of printed output, 8 of which are tables of average ground-level concentration or total ground-level deposition. All program printed output is optional except warning and error messages. The printed output categories are:

- Input Source Data
- Input Data Other than Source Data
- Seasonal Concentration (Deposition) from Individual Sources

- Seasonal Concentration (Deposition) from Combined Sources
- Annual Concentration (Deposition) from Individual Sources
- Annual Concentration (Deposition) from Combined Sources
- Seasonal Maximum 10 Concentration (Deposition) Values from Individual Sources
- Seasonal Maximum 10 Concentration (Deposition) Values from Combined Sources
- Annual Maximum 10 Concentration (Deposition) Values from Individual Sources
- Annual Maximum 10 Concentration (Deposition) Values from Combined Sources
- Warning and Error Messages

The first line of each page of output contains the run title (TITLE) and page number followed by the major heading of the type or category of output table.

The first category of printed output is the input card data except for the source data. This output is optional and is selected by the option parameter ISW(6). Figure 4-2 shows an example of the printed input data. The example output shown in this section is output generated from an example problem given in Section 2.6. The second category of printed output is the source input data. Figure 4-3 shows an example of the source input data table. This example shows each input source listed down the page. However, if the user is printing tables for individual sources, the source input data may be printed prior to each concentration or deposition output table for each source. The third through tenth categories of output tables are concentration or deposition tables. Figures 4-4 through 4-10 show an example of each type of output table. These tables are defined by their respective headings and are all optional, depending on the parameters ISW(7), ISW(8), ISW(10) and ISW(11) or ISW(12). Also, the ISCLT program has an option (ISW(16)) of compressing the output tables by minimizing the number of new pages started by new tables. This option will save on the paper output, but the user should become familiar

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**** ISCLT *************                     HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE     1 ****

                                          - ISCLT INPUT DATA -

         NUMBER OF SOURCES =  16
         NUMBER OF X AXIS GRID SYSTEM POINTS =    19
         NUMBER OF Y AXIS GRID SYSTEM POINTS =    19
         NUMBER OF SPECIAL POINTS =    1
         NUMBER OF SEASONS =    4
         NUMBER OF WIND SPEED CLASSES =    6
         NUMBER OF STABILITY CLASSES =    6
         NUMBER OF WIND DIRECTION CLASSES =  16
         FILE NUMBER OF DATA FILE USED FOR REPORTS =    1
         THE PROGRAM IS RUN IN RURAL MODE
         CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =   .10000000+07
         ACCELERATION OF GRAVITY (METERS/SEC**2) =  9.800
         HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) =  10.000
         ENTRAINMENT PARAMETER FOR UNSTABLE CONDITIONS =   .600
         ENTRAINMENT PARAMETER FOR STABLE CONDITIONS =  .600
         CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) =     .000
         DECAY COEFFICIENT =  .00000000
         PROGRAM OPTION SWITCHES = 1, 1, 2, 0, 0, 3, 3, 3, 3, 2, 2, 0, 0, 0, 0, 0, 0, 0, 1, 0,
         SOURCES USED TO FORM SOURCE COMBINATION  1 ARE -      1,
         SOURCES USED TO FORM SOURCE COMBINATION  2 ARE -      2,   -11,
         SOURCES USED TO FORM SOURCE COMBINATION  3 ARE -     12,   -15,
         SOURCES USED TO FORM SOURCE COMBINATION  4 ARE -     16,
         SOURCES USED TO FORM SOURCE COMBINATION  5 ARE -    -16,
       DISTANCE X AXIS GRID SYSTEM POINTS (METERS )=   -3000.00,   -2000.00,   -1500.00,   -1250 00,   -1000.00,    -800.00,
           -600 00,    -400.00,    -200.00,          .00,      200.00,      400.00,      600.00,      800.00,     1000.00,     1250.00,
           1500.00,    2000.00,    3000 00,
          RANGE X SPECIAL DISCRETE POINTS (METERS )=     2108.00,
       DISTANCE Y AXIS GRID SYSTEM POINTS (METERS )=   -3000.00,   -2000.00,   -1500.00,   -1250 00,   -1000.00,    -800.00,
           -600 00,    -400.00,    -200.00,          .00,      200.00,      400.00,      600.00,      800.00,     1000.00,     1250.00,
           1500.00,    2000.00,    3000.00,
  AZIMUTH BEARING Y SPECIAL DISCRETE POINTS (DEGREES)=      14.00,
                             - AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -

                   STABILITY  STABILITY  STABILITY  STABILITY  STABILITY  STABILITY
                   CATEGORY 1 CATEGORY 2 CATEGORY 3 CATEGORY 4 CATEGORY 5 CATEGORY 6
         SEASON  1   287.2000   287.2000   283.2000   280.8000   279.1000   279.1000
         SEASON  2   287.2000   287.2000   283.2000   280.8000   279.1000   279.1000
         SEASON  3   287.2000   287.2000   283.2000   280.8000   279.1000   279.1000
         SEASON  4   287 2000   287.2000   283.2000   280.8000   279.1000   279.1000
```

FIGURE 4-2. Example listing of input data for the calculation of seasonal and annual ground-level particulate concentration from a hypothetical potash processing plant.

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**** ISCLT *************             HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE    2 ****

                                       - ISCLT INPUT DATA (CONT.) -

                                     - MIXING LAYER HEIGHT (METERS) -

                                                  SEASON 1
                      WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                      CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
STABILITY CATEGORY 1  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 2  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 3  .960000+03   .102500+04   .123500+04   .129500+04   .129500+04   .129500+04
STABILITY CATEGORY 4  .320000+03   .500000+03   .840000+03   .840000+03   .840000+03   .840000+03
STABILITY CATEGORY 5  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
STABILITY CATEGORY 6  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
                                                  SEASON 2
                      WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                      CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
STABILITY CATEGORY 1  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 2  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 3  .960000+03   .102500+04   .123500+04   .129500+04   .129500+04   .129500+04
STABILITY CATEGORY 4  .320000+03   .500000+03   .840000+03   .840000+03   .840000+03   .840000+03
STABILITY CATEGORY 5  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
STABILITY CATEGORY 6  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
                                                  SEASON 3
                      WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                      CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
STABILITY CATEGORY 1  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 2  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 3  .960000+03   .102500+04   .123500+04   .129500+04   .129500+04   .129500+04
STABILITY CATEGORY 4  .320000+03   .500000+03   .840000+03   .840000+03   .840000+03   .840000+03
STABILITY CATEGORY 5  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
STABILITY CATEGORY 6  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
                                                  SEASON 4
                      WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                      CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
STABILITY CATEGORY 1  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 2  .173000+04   .173000+04   .173000+04   .173000+04   .173000+04   .173000+04
STABILITY CATEGORY 3  .960000+03   .102500+04   .123500+04   .129500+04   .129500+04   .129500+04
STABILITY CATEGORY 4  .320000+03   .500000+03   .840000+03   .840000+03   .840000+03   .840000+03
STABILITY CATEGORY 5  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
STABILITY CATEGORY 6  .100000+05   .100000+05   .100000+05   .100000+05   .100000+05   .100000+05
```

FIGURE 4-2. (Continued)

```
                              - ISCLT INPUT DATA (CONT.) -

                 - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                        SEASON 1
                                  STABILITY CATEGORY 1

                WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
  DIRECTION    (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
 (DEGREES)
        .000     .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
     22.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
     45.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
     67.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
     90.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    112.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    135.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    157.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    180.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    202.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    225.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    247.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    270.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    292.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    315.000      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
    337.500      .00002890    .00000000    .00000000    .00000000    .00000000    .00000000
                                        SEASON 1
                                  STABILITY CATEGORY 2

                WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
  DIRECTION    (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
 (DEGREES)
        .000     .00113800    .00000000    .00011580    .00000000    .00000000    .00000000
     22.500      .00073830    .00011580    .00000000    .00000000    .00000000    .00000000
     45.000      .00042700    .00000000    .00000000    .00000000    .00000000    .00000000
     67.500      .00110280    .00046300    .00011580    .00000000    .00000000    .00000000
     90.000      .00160960    .00081030    .00000000    .00000000    .00000000    .00000000
    112.500      .00160960    .00081030    .00034730    .00000000    .00000000    .00000000
    135.000      .00167220    .00046300    .00011580    .00000000    .00000000    .00000000
    157.500      .00235730    .00034730    .00023150    .00000000    .00000000    .00000000
    180.000      .00419840    .00092600    .00023150    .00000000    .00000000    .00000000
    202.500      .00243710    .00069450    .00000000    .00000000    .00000000    .00000000
    225.000      .00102300    .00011580    .00000000    .00000000    .00000000    .00000000
    247.500      .00144070    .00069450    .00011580    .00000000    .00000000    .00000000
    270.000      .00283750    .00057880    .00023150    .00000000    .00000000    .00000000
    292.500      .00145010    .00011580    .00000000    .00000000    .00000000    .00000000
    315.000      .00085410    .00000000    .00034730    .00000000    .00000000    .00000000
    337.500      .00045360    .00011580    .00011580    .00000000    .00000000    .00000000
```

FIGURE 4-2. (Continued)

```
**** ISCLT *************            HYPOTHETICAL POTASH PROCESSING PLANT                         ******** PAGE     4 ****

                                          - ISCLT INPUT DATA (CONT.) -

                          - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                                   SEASON 1
                                              STABILITY CATEGORY 3

                  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                  CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
  DIRECTION     (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
 (DEGREES)
        000       .00068080   .00081030   .00046300   .00000000   .00000000   .00000000
     22.500       .00053100   .00046300   .00034730   .00011580   .00000000   .00000000
     45.000       .00029100   .00057880   .00081030   .00000000   .00000000   .00000000
     67.500       .00079130   .00231510   .00069450   .00000000   .00000000   .00000000
     90.000       .00086780   .00335690   .00416710   .00000000   .00000000   .00000000
    112.500       .00104630   .00578770   .00474590   .00000000   .00000000   .00000000
    135.000       .00054600   .00405140   .00474590   .00023150   .00000000   .00000000
    157.500       .00071280   .00463020   .00439870   .00000000   .00000000   .00000000
    180.000       .00144130   .00439870   .00358840   .00000000   .00000000   .00000000
    202.500       .00142430   .00416710   .00138900   .00000000   .00000000   .00000000
    225.000       .00079130   .00231510   .00092600   .00011580   .00000000   .00000000
    247.500       .00086780   .00335690   .00150480   .00000000   .00000000   .00000000
    270.000       .00151460   .00370410   .00358840   .00011580   .00000000   .00000000
    292.500       .00076580   .00196780   .00173630   .00011580   .00000000   .00000000
    315.000       .00031650   .00092600   .00081030   .00000000   .00000000   .00000000
    337.500       .00095480   .00115750   .00092600   .00000000   .00000000   .00000000
                                                   SEASON 1
                                              STABILITY CATEGORY 4

                  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                  CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
  DIRECTION     (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
 (DEGREES)
        000       .00090470   .00196780   .00902880   .01180690   .01319600   .01076510
     22.500       .00077370   .00347260   .00937610   .01088090   .00798700   .00463020
     45.000       .00050260   .00162060   .00601920   .00381990   .00162060   .00046300
     67.500       .00062450   .00474590   .00787130   .00347260   .00034730   .00000000
     90.000       .00187340   .00949180   .01331170   .00601920   .00092600   .00000000
    112.500       .00129770   .00694520   .01794191   .00972330   .00138900   .00023150
    135.000       .00071280   .00428290   .00868160   .00636650   .00023150   .00000000
    157.500       .00068540   .00393560   .00578770   .00428290   .00023150   .00000000
    180.000       .00126420   .00335690   .00497740   .00185210   .00023150   .00000000
    202.500       .00028330   .00358840   .00243080   .00104180   .00057880   .00034730
    225.000       .00074330   .00150480   .00277810   .00300960   .00115750   .00081030
    247.500       .00046000   .00266230   .00694520   .00729250   .00208360   .00196780
    270.000       .00196480   .00590350   .01122820   .02419261   .01319600   .00995490
    292.500       .00135250   .00289390   .00717680   .01921521   .01852071   .01284870
    315.000       .00044170   .00243080   .00532470   .01041790   .00532470   .00266230
    337.500       .00070060   .00254660   .00625070   .00613500   .00277810   .00208360
```

FIGURE 4-2. (Continued)

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**** ISCLT *************           HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE     5 ****

                                     - ISCLT INPUT DATA (CONT.) -

                     - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                              SEASON 1
                                        STABILITY CATEGORY 5

                WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
 DIRECTION    (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
(DEGREES)
      000       .00000000   .00555620   .00636650   .00000000   .00000000   .00000000
   22.500       .00000000   .00428290   .00497740   .00000000   .00000000   .00000000
   45.000       .00000000   .00069450   .00555620   .00000000   .00000000   .00000000
   67.500       .00000000   .00544040   .00636650   .00000000   .00000000   .00000000
   90.000       .00000000   .00706100   .00694520   .00000000   .00000000   .00000000
  112.500       .00000000   .00428290   .00416710   .00000000   .00000000   .00000000
  135.000       .00000000   .00289390   .00324110   .00000000   .00000000   .00000000
  157.500       .00000000   .00393560   .00231510   .00000000   .00000000   .00000000
  180.000       .00000000   .00370410   .00231510   .00000000   .00000000   .00000000
  202.500       .00000000   .00254660   .00115750   .00000000   .00000000   .00000000
  225.000       .00000000   .00150480   .00300960   .00000000   .00000000   .00000000
  247.500       .00000000   .00486170   .00798700   .00000000   .00000000   .00000000
  270.000       .00000000   .00833430   .01458500   .00000000   .00000000   .00000000
  292.500       .00000000   .00729250   .00729250   .00000000   .00000000   .00000000
  315.000       .00000000   .00532470   .00625070   .00000000   .00000000   .00000000
  337.500       .00000000   .00775550   .00914460   .00000000   .00000000   .00000000
                                              SEASON 1
                                        STABILITY CATEGORY 6

                WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
 DIRECTION    (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
(DEGREES)
      000       .00941660   .01076510   .00000000   .00000000   .00000000   .00000000
   22.500       .00495710   .00567200   .00000000   .00000000   .00000000   .00000000
   45.000       .00361460   .00486170   .00000000   .00000000   .00000000   .00000000
   67.500       .00221280   .00451440   .00000000   .00000000   .00000000   .00000000
   90.000       .00599280   .00625070   .00000000   .00000000   .00000000   .00000000
  112.500       .00428740   .00486170   .00000000   .00000000   .00000000   .00000000
  135.000       .00423100   .00451440   .00000000   .00000000   .00000000   .00000000
  157.500       .00559820   .00381990   .00000000   .00000000   .00000000   .00000000
  180.000       .00586130   .00544040   .00000000   .00000000   .00000000   .00000000
  202.500       .00616800   .00567200   .00000000   .00000000   .00000000   .00000000
  225.000       .00551710   .00497740   .00000000   .00000000   .00000000   .00000000
  247.500       .00850630   .01261720   .00000000   .00000000   .00000000   .00000000
  270.000       .01735381   .02650771   .00000000   .00000000   .00000000   .00000000
  292.500       .01135430   .01690011   .00000000   .00000000   .00000000   .00000000
  315.000       .00917300   .01423780   .00000000   .00000000   .00000000   .00000000
  337.500       .00977360   .01296450   .00000000   .00000000   .00000000   .00000000
```

FIGURE 4-2. (Continued)

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**** ISCLT *************              HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE     6 ****

                                            - ISCLT INPUT DATA (CONT.) -

                              - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                                      SEASON 2
                                                 STABILITY CATEGORY 1

                     WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                     CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
   DIRECTION       (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
  (DEGREES)
         .000        .00000000   .00000000   .00000000   .00000000   .00000000   .00000000
       22.500        .00018080   .00011320   .00000000   .00000000   .00000000   .00000000
       45.000        .00006760   .00022640   .00000000   .00000000   .00000000   .00000000
       67.500        .00013520   .00045290   .00000000   .00000000   .00000000   .00000000
       90.000        .00046300   .00056610   .00000000   .00000000   .00000000   .00000000
      112.500        .00041740   .00090580   .00000000   .00000000   .00000000   .00000000
      135.000        .00050870   .00022640   .00000000   .00000000   .00000000   .00000000
      157.500        .00039540   .00033970   .00000000   .00000000   .00000000   .00000000
      180.000        .00053060   .00079260   .00000000   .00000000   .00000000   .00000000
      202.500        .00061010   .00056610   .00000000   .00000000   .00000000   .00000000
      225.000        .00028220   .00045290   .00000000   .00000000   .00000000   .00000000
      247.500        .00018080   .00011320   .00000000   .00000000   .00000000   .00000000
      270.000        .00036160   .00022640   .00000000   .00000000   .00000000   .00000000
      292.500        .00000000   .00000000   .00000000   .00000000   .00000000   .00000000
      315.000        .00006760   .00022640   .00000000   .00000000   .00000000   .00000000
      337.500        .00021460   .00022640   .00000000   .00000000   .00000000   .00000000
                                                      SEASON 2
                                                 STABILITY CATEGORY 2

                     WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                     CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
   DIRECTION       (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
  (DEGREES)
         .000        .00058450   .00101900   .00090580   .00000000   .00000000   .00000000
       22.500        .00135500   .00135870   .00079260   .00000000   .00000000   .00000000
       45.000        .00008100   .00090580   .00033970   .00000000   .00000000   .00000000
       67.500        .00117920   .00215130   .00090580   .00000000   .00000000   .00000000
       90.000        .00197820   .00418930   .00249090   .00000000   .00000000   .00000000
      112.500        .00171310   .00260420   .00362320   .00000000   .00000000   .00000000
      135.000        .00168090   .00362320   .00339670   .00000000   .00000000   .00000000
      157.500        .00238050   .00317030   .00317030   .00000000   .00000000   .00000000
      180.000        .00296500   .00418930   .00226450   .00000000   .00000000   .00000000
      202.500        .00201040   .00317030   .00079260   .00000000   .00000000   .00000000
      225.000        .00107790   .00101900   .00067930   .00000000   .00000000   .00000000
      247.500        .00137340   .00294380   .00101900   .00000000   .00000000   .00000000
      270.000        .00245320   .00260420   .00169840   .00000000   .00000000   .00000000
      292.500        .00148850   .00147190   .00067930   .00000000   .00000000   .00000000
      315.000        .00107790   .00101900   .00033970   .00000000   .00000000   .00000000
      337.500        .00094450   .00090580   .00033970   .00000000   .00000000   .00000000
```

FIGURE 4-2. (Continued)

```
**** ISCLT *************            HYPOTHETICAL POTASH PROCESSING PLANT                           ********* PAGE     7 ****

                                       - ISCLT INPUT DATA (CONT.) -

                         - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                                 SEASON 2
                                           STABILITY CATEGORY 3

                WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
   DIRECTION   (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
  (DEGREES)
         000     .00032330   .00135870   .00181160   .00022640   .00000000   .00000000
      22 500     .00041580   .00090580   .00192480   .00011320   .00011320   .00011320
      45 000     .00005540   .00090580   .00135870   .00045290   .00000000   .00000000
      67 500     .00058440   .00169840   .00124550   .00079260   .00000000   .00000000
      90 000     .00062590   .00237770   .00724641   .00045290   .00011320   .00000000
     112 500     .00058880   .00373640   .00735961   .00192480   .00022640   .00000000
     135 000     .00031390   .00317030   .00668031   .00271740   .00011320   .00000000
     157 500     .00057490   .00351000   .00679351   .00192480   .00033970   .00000000
     180 000     .00071580   .00384960   .00622741   .00033970   .00011320   .00000000
     202 500     .00032080   .00328350   .00362320   .00033970   .00000000   .00033970
     225 000     .00028870   .00079260   .00249090   .00033970   .00022640   .00045290
     247 500     .00034160   .00362320   .00362320   .00090580   .00011320   .00090580
     270 000     .00097690   .00418930   .00656701   .00215130   .00079260   .00079260
     292 500     .00067680   .00124550   .00384960   .00079260   .00045290   .00067930
     315 000     .00005540   .00090580   .00135870   .00033970   .00000000   .00011320
     337 500     .00016170   .00067930   .00158510   .00011320   .00022640   .00000000
                                                 SEASON 2
                                           STABILITY CATEGORY 4

                WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
   DIRECTION   (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
  (DEGREES)
         000     .00099440   .00362320   .00690671   .01766302   .01222831   .01607792
      22 500     .00093640   .00283060   .00939761   .01698372   .00928441   .00747281
      45 000     .00010780   .00147190   .00769931   .00713321   .00237770   .00090580
      67 500     .00101930   .00396290   .01154891   .00860511   .00169840   .00033970
      90 000     .00155510   .00464221   .01936142   .02015402   .00362320   .00033970
     112 500     .00096410   .00486871   .01664402   .01732342   .00464221   .00090580
     135 000     .00066300   .00407610   .00894471   .01234151   .00317030   .00011320
     157 500     .00131750   .00305710   .00713321   .00917121   .00283060   .00056610
     180 000     .00079280   .00418930   .00520831   .00735961   .00283060   .00158510
     202 500     .00091150   .00249090   .00283060   .00520831   .00317030   .00135870
     225 000     .00045570   .00124550   .00192480   .00577451   .00407610   .00373640
     247 500     .00030110   .00079260   .00475541   .00871831   .00668031   .00509511
     270 000     .00122910   .00351000   .00724641   .01460602   .01132251   .00871831
     292 500     .00018780   .00090580   .00464221   .01347371   .00985051   .00611411
     315 000     .00024590   .00169840   .00396290   .00634061   .00260420   .00339670
     337 500     .00054690   .00249090   .00713321   .00600091   .00294380   .00249090
```

FIGURE 4-2. (Continued)

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**** ISCLT *************         HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE      8 ****

                                      - ISCLT INPUT DATA (CONT.) -

                      - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                                SEASON 2
                                          STABILITY CATEGORY 5

                  WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                  CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
   DIRECTION     (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
   (DEGREES)
         .000      .00000000    .00430250    .00939761    .00000000    .00000000    .00000000
       22.500      .00000000    .00181160    .00701991    .00000000    .00000000    .00000000
       45.000      .00000000    .00090580    .00645381    .00000000    .00000000    .00000000
       67.500      .00000000    .00203800    .00724641    .00000000    .00000000    .00000000
       90.000      .00000000    .00305710    .00928441    .00000000    .00000000    .00000000
      112.500      .00000000    .00113220    .00362320    .00000000    .00000000    .00000000
      135.000      .00000000    .00101900    .00203800    .00000000    .00000000    .00000000
      157.500      .00000000    .00124550    .00135870    .00000000    .00000000    .00000000
      180.000      .00000000    .00169840    .00135870    .00000000    .00000000    .00000000
      202.500      .00000000    .00192480    .00158510    .00000000    .00000000    .00000000
      225.000      .00000000    .00169840    .00169840    .00000000    .00000000    .00000000
      247.500      .00000000    .00294380    .00452900    .00000000    .00000000    .00000000
      270.000      .00000000    .00520831    .00996381    .00000000    .00000000    .00000000
      292.500      .00000000    .00260420    .00668031    .00000000    .00000000    .00000000
      315.000      .00000000    .00158510    .00724641    .00000000    .00000000    .00000000
      337.500      .00000000    .00249090    .00815221    .00000000    .00000000    .00000000
                                                SEASON 2
                                          STABILITY CATEGORY 6

                  WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                  CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
   DIRECTION     (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
   (DEGREES)
         .000      .00533241    .00905801    .00000000    .00000000    .00000000    .00000000
       22.500      .00273120    .00509511    .00000000    .00000000    .00000000    .00000000
       45.000      .00159130    .00396290    .00000000    .00000000    .00000000    .00000000
       67.500      .00215740    .00339670    .00000000    .00000000    .00000000    .00000000
       90.000      .00337540    .00520831    .00000000    .00000000    .00000000    .00000000
      112.500      .00165640    .00452900    .00000000    .00000000    .00000000    .00000000
      135.000      .00291100    .00226450    .00000000    .00000000    .00000000    .00000000
      157.500      .00217580    .00135870    .00000000    .00000000    .00000000    .00000000
      180.000      .00574011    .00271740    .00000000    .00000000    .00000000    .00000000
      202.500      .00302810    .00328350    .00000000    .00000000    .00000000    .00000000
      225.000      .00114380    .00226450    .00000000    .00000000    .00000000    .00000000
      247.500      .00394000    .00792571    .00000000    .00000000    .00000000    .00000000
      270.000      .00629641    .01415312    .00000000    .00000000    .00000000    .00000000
      292.500      .00583731    .00905801    .00000000    .00000000    .00000000    .00000000
      315.000      .00446180    .00917121    .00000000    .00000000    .00000000    .00000000
      337.500      .00525291    .01166211    .00000000    .00000000    .00000000    .00000000
```

FIGURE 4-2. (Continued)

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**** ISCLT *************          HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE     9 ****

                                      - ISCLT INPUT DATA (CONT.) -

                    - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                               SEASON 3
                                         STABILITY CATEGORY 1

              WIND SPEED  WIND SPEED  WIND SPEED  WIND SPE    WIND SPEED  WIND SPEED
              CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
 DIRECTION   (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
(DEGREES)
      .000     .00058880   .00034010   .00000000   .00000000   .00000000   .00000000
    22.500     .00024870   .00068010   .00000000   .00000000   .00000000   .00000000
    45.000     .00022940   .00056680   .00000000   .00000000   .00000000   .00000000
    67.500     .00022940   .00056680   .00000000   .00000000   .00000000   .00000000
    90.000     .00057480   .00181360   .00000000   .00000000   .00000000   .00000000
   112.500     .00085690   .00113350   .00000000   .00000000   .00000000   .00000000
   135.000     .00085690   .00113350   .00000000   .00000000   .00000000   .00000000
   157.500     .00194310   .00283380   .00000000   .00000000   .00000000   .00000000
   180.000     .00177170   .00260710   .00000000   .00000000   .00000000   .00000000
   202.500     .00133230   .00158690   .00000000   .00000000   .00000000   .00000000
   225.000     .00022940   .00056680   .00000000   .00000000   .00000000   .00000000
   247.500     .00017410   .00102020   .00000000   .00000000   .00000000   .00000000
   270.000     .00066620   .00079350   .00000000   .00000000   .00000000   .00000000
   292.500     .00024870   .00068010   .00000000   .00000000   .00000000   .00000000
   315.000     .00015200   .00011340   .00000000   .00000000   .00000000   .00000000
   337.500     .00077950   .00068010   .00000000   .00000000   .00000000   .00000000
                                               SEASON 3
                                         STABILITY CATEGORY 2

              WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
              CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
 DIRECTION   (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
(DEGREES)
      .000     .00078840   .00102020   .00113350   .00000000   .00000000   .00000000
    22.500     .00095220   .00170030   .00113350   .00000000   .00000000   .00000000
    45.000     .00078840   .00102020   .00045340   .00000000   .00000000   .00000000
    67.500     .00057610   .00147360   .00192700   .00000000   .00000000   .00000000
    90.000     .00181790   .00204040   .00351390   .00000000   .00000000   .00000000
   112.500     .00165100   .00510090   .00566760   .00000000   .00000000   .00000000
   135.000     .00196940   .00442080   .00861480   .00000000   .00000000   .00000000
   157.500     .00280320   .00804810   .01224210   .00000000   .00000000   .00000000
   180.000     .00544640   .00600770   .00714120   .00000000   .00000000   .00000000
   202.500     .00333900   .00510090   .00215370   .00000000   .00000000   .00000000
   225.000     .00154070   .00147360   .00147360   .00000000   .00000000   .00000000
   247.500     .00213120   .00317390   .00113350   .00000000   .00000000   .00000000
   270.000     .00192610   .00374060   .00158690   .00000000   .00000000   .00000000
   292.500     .00169730   .00204040   .00192700   .00000000   .00000000   .00000000
   315.000     .00088730   .00068010   .00079350   .00000000   .00000000   .00000000
   337.500     .00093060   .00136020   .00079350   .00000000   .00000000   .00000000
```

FIGURE 4-2. (Continued)

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**** ISCLT *************              HYPOTHETICAL POTASH PROCESSING PLANT                         ******** PAGE     10 ****

                                         - ISCLT INPUT DATA (CONT ) -

                     - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                                 SEASON 3
                                           STABILITY CATEGORY 3

                  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                  CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
   DIRECTION     (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
   (DEGREES)
         000       .00016630   .00090680   .00204040   .00034010   .00011340   .00000000
      22.500       .00027970   .00079350   .00215370   .00124690   .00045340   .00000000
      45.000       .00027380   .00068010   .00113350   .00124690   .00011340   .00000000
      67.500       .00039890   .00079350   .00238040   .00068010   .00022670   .00000000
      90.000       .00041660   .00113350   .00476080   .00170030   .00022670   .00000000
     112.500       .00045190   .00181360   .00940830   .00612110   .00034010   .00000000
     135.000       .00046960   .00215370   .01008840   .00872820   .00056680   .00000000
     157.500       .00028410   .00317390   .01212880   .00736790   .00045340   .00000000
     180.000       .00099960   .00317390   .00600770   .00170030   .00034010   .00011340
     202.500       .00024290   .00238040   .00204040   .00068010   .00045340   .00000000
     225.000       .00030330   .00124690   .00147360   .00124690   .00011340   .00011340
     247.500       .00064770   .00328720   .00249380   .00102020   .00056680   .00045340
     270.000       .00098190   .00283380   .00702790   .00192700   .00034010   .00056680
     292.500       .00082730   .00215370   .00464750   .00102020   .00056680   .00022670
     315.000       .00030330   .00124690   .00215370   .00034010   .00022670   .00000000
     337.500       .00043430   .00147360   .00102020   .00034010   .00000000   .00000000
                                                 SEASON 3
                                           STABILITY CATEGORY 4

                  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                  CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
   DIRECTION     (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
   (DEGREES)
         000       .00068600   .00147360   .00725460   .01258220   .01156200   .00510090
      22.500       .00019280   .00124690   .00793470   .01416910   .00850150   .00408070
      45.000       .00010600   .00181360   .00521420   .00589440   .00272050   .00034010
      67.500       .00066540   .00317390   .00668700   .00782140   .00170030   .00034010
      90.000       .00093180   .00362730   .01201540   .01326230   .00249380   .00056680
     112.500       .00088550   .00283380   .01178870   .02652460   .00578100   .00068010
     135.000       .00047250   .00192700   .00793470   .01722970   .00238040   .00045340
     157.500       .00056600   .00147360   .00600770   .00918160   .00124690   .00034010
     180.000       .00049240   .00226710   .00442080   .00589440   .00136020   .00056680
     202.500       .00021930   .00170030   .00215370   .00328720   .00068010   .00000000
     225.000       .00016630   .00079350   .00283380   .00351390   .00192700   .00011340
     247.500       .00027970   .00068010   .00566760   .00340060   .00079350   .00068010
     270.000       .00041220   .00294720   .00963500   .01020180   .00260710   .00158690
     292.500       .00045270   .00158690   .01167540   .01054180   .00555430   .00317390
     315.000       .00016630   .00079350   .00691450   .00838810   .00238040   .00034010
     337.500       .00089950   .00102020   .00691450   .00589440   .00328720   .00090680
```

FIGURE 4-2. (Continued)

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**** ISCLT *************          HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE    11 ****

                                   - ISCLT INPUT DATA (CONT.) -

                      - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                             SEASON 3
                                       STABILITY CATEGORY 5

                   WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                   CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
     DIRECTION   (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
     (DEGREES)
          .000      .00000000   .00668780   .00929490   .00000000   .00000000   .00000000
        22.500      .00000000   .00374060   .00895490   .00000000   .00000000   .00000000
        45.000      .00000000   .00294720   .00374060   .00000000   .00000000   .00000000
        67.500      .00000000   .00272050   .00714120   .00000000   .00000000   .00000000
        90.000      .00000000   .00510090   .01156200   .00000000   .00000000   .00000000
       112.500      .00000000   .00317390   .00589440   .00000000   .00000000   .00000000
       135.000      .00000000   .00136020   .00147360   .00000000   .00000000   .00000000
       157.500      .00000000   .00181360   .00113350   .00000000   .00000000   .00000000
       180.000      .00000000   .00192700   .00136020   .00000000   .00000000   .00000000
       202.500      .00000000   .00136020   .00102020   .00000000   .00000000   .00000000
       225.000      .00000000   .00158690   .00170030   .00000000   .00000000   .00000000
       247.500      .00000000   .00294720   .00396740   .00000000   .00000000   .00000000
       270.000      .00000000   .00748130   .00952170   .00000000   .00000000   .00000000
       292.500      .00000000   .00600770   .00657450   .00000000   .00000000   .00000000
       315.000      .00000000   .00442080   .00600770   .00000000   .00000000   .00000000
       337.500      .00000000   .00646110   .00918160   .00000000   .00000000   .00000000
                                             SEASON 3
                                       STABILITY CATEGORY 6

                   WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                   CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
     DIRECTION   (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
     (DEGREES)
          .000      .00727720   .00884150   .00000000   .00000000   .00000000   .00000000
        22.500      .00325950   .00612110   .00000000   .00000000   .00000000   .00000000
        45.000      .00203440   .00430740   .00000000   .00000000   .00000000   .00000000
        67.500      .00273330   .00374060   .00000000   .00000000   .00000000   .00000000
        90.000      .00425940   .00657450   .00000000   .00000000   .00000000   .00000000
       112.500      .00316720   .00396740   .00000000   .00000000   .00000000   .00000000
       135.000      .00230090   .00192700   .00000000   .00000000   .00000000   .00000000
       157.500      .00284890   .00124690   .00000000   .00000000   .00000000   .00000000
       180.000      .00299970   .00136020   .00000000   .00000000   .00000000   .00000000
       202.500      .00518800   .00260710   .00000000   .00000000   .00000000   .00000000
       225.000      .00205540   .00204040   .00000000   .00000000   .00000000   .00000000
       247.500      .00597770   .00578100   .00000000   .00000000   .00000000   .00000000
       270.000      .00893320   .01405580   .00000000   .00000000   .00000000   .00000000
       292.500      .00527660   .00872820   .00000000   .00000000   .00000000   .00000000
       315.000      .00509040   .00600770   .00000000   .00000000   .00000000   .00000000
       337.500      .00653700   .01314890   .00000000   .00000000   .00000000   .00000000
```

FIGURE 4-2. (Continued)

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**** ISCLT *************          HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE    12 ****

                                   - ISCLT INPUT DATA (CONT.) -

                       - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                             SEASON 4
                                        STABILITY CATEGORY 1

                       WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                       CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
         DIRECTION    (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
         (DEGREES)
              .000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
            22.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
            45.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
            67.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
            90.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           112.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           135.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           157.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           180.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           202.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           225.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           247.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           270.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           292.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           315.000      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
           337.500      .00012160   .00000000   .00000000   .00000000   .00000000   .00000000
                                             SEASON 4
                                        STABILITY CATEGORY 2

                       WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED  WIND SPEED
                       CATEGORY 1  CATEGORY 2  CATEGORY 3  CATEGORY 4  CATEGORY 5  CATEGORY 6
         DIRECTION    (   .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
         (DEGREES)
              .000      .00047580   .00103020   .00011450   .00000000   .00000000   .00000000
            22.500      .00111440   .00114470   .00000000   .00000000   .00000000   .00000000
            45.000      .00045380   .00080130   .00000000   .00000000   .00000000   .00000000
            67.500      .00105510   .00183150   .00045790   .00000000   .00000000   .00000000
            90.000      .00215440   .00412090   .00068680   .00000000   .00000000   .00000000
           112.500      .00175990   .00263280   .00137360   .00000000   .00000000   .00000000
           135.000      .00253090   .00412090   .00148810   .00000000   .00000000   .00000000
           157.500      .00280390   .00434980   .00125920   .00000000   .00000000   .00000000
           180.000      .00582300   .00572340   .00171700   .00000000   .00000000   .00000000
           202.500      .00270460   .00331960   .00125920   .00000000   .00000000   .00000000
           225.000      .00217360   .00171700   .00034340   .00000000   .00000000   .00000000
           247.500      .00166060   .00160260   .00057230   .00000000   .00000000   .00000000
           270.000      .00290460   .00148810   .00091580   .00000000   .00000000   .00000000
           292.500      .00073790   .00114470   .00045790   .00000000   .00000000   .00000000
           315.000      .00085230   .00103020   .00034340   .00000000   .00000000   .00000000
           337.500      .00055720   .00057230   .00022890   .00000000   .00000000   .00000000
```

FIGURE 4-2. (Continued)

```
**** ISCLT *************              HYPOTHETICAL POTASH PROCESSING PLANT                           ******** PAGE    13 ****

                                        - ISCLT INPUT DATA (CONT.) -

                           - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                                  SEASON 4
                                            STABILITY CATEGORY 3

                 WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                 CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
  DIRECTION    (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
 (DEGREES)
       .000      .00068200    .00068680    .00068680    .00000000    .00000000    .00000000
     22.500      .00158310    .00103020    .00160260    .00045790    .00000000    .00000000
     45.000      .00044310    .00080130    .00045790    .00000000    .00000000    .00000000
     67.500      .00033860    .00103020    .00194600    .00022890    .00000000    .00000000
     90.000      .00087670    .00434980    .00721150    .00068680    .00000000    .00000000
    112.500      .00070240    .00377750    .00629580    .00034340    .00000000    .00000000
    135.000      .00099600    .00286170    .00869960    .00091580    .00000000    .00000000
    157.500      .00087200    .00572340    .00904300    .00103020    .00000000    .00000000
    180.000      .00154880    .00492220    .00457880    .00045790    .00000000    .00000000
    202.500      .00112560    .00434980    .00274730    .00000000    .00000000    .00000000
    225.000      .00106060    .00217490    .00320510    .00011450    .00000000    .00000000
    247.500      .00144430    .00515110    .00389190    .00011450    .00000000    .00000000
    270.000      .00221610    .00686810    .00663920    .00022890    .00000000    .00000000
    292.500      .00114040    .00309070    .00331960    .00011450    .00000000    .00000000
    315.000      .00072190    .00114470    .00103020    .00000000    .00000000    .00000000
    337.500      .00107530    .00091580    .00022890    .00000000    .00000000    .00000000
                                                  SEASON 4
                                            STABILITY CATEGORY 4

                 WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                 CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
  DIRECTION    (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
 (DEGREES)
       .000      .00122790    .00331960    .00847070    .01259161    .00812730    .00915750
     22.500      .00086760    .00343410    .00881410    .01179031    .00652470    .00400640
     45.000      .00087240    .00183150    .00744050    .00526560    .00148810    .00045790
     67.500      .00106640    .00446430    .00835620    .00469320    .00080130    .00011450
     90.000      .00359570    .00709710    .01488101    .01030221    .00068680    .00000000
    112.500      .00221840    .00675370    .02014651    .01991761    .00103020    .00011450
    135.000      .00102430    .00389190    .01076011    .01156141    .00103020    .00022890
    157.500      .00137130    .00526560    .00744050    .00538000    .00045790    .00011450
    180.000      .00149420    .00526560    .00412090    .00286170    .00057230    .00034340
    202.500      .00090140    .00389190    .00114470    .00412090    .00080130    .00022890
    225.000      .00063500    .00194600    .00148810    .00148810    .00080130    .00034340
    247.500      .00121100    .00309070    .00286170    .00412090    .00183150    .00057230
    270.000      .00130750    .00606680    .00847070    .01053111    .00457880    .00286170
    292.500      .00081700    .00274730    .00618130    .01350731    .00869960    .00434980
    315.000      .00130020    .00263280    .00423530    .00526560    .00148810    .00137360
    337.500      .00080860    .00263280    .00583790    .00434980    .00148810    .00051580
```

FIGURE 4-2. (Continued)

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**** ISCLT *************          HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE    14 ****

                                    - ISCLT INPUT DATA (CONT.) -

                     - FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY -
                                              SEASON 4
                                        STABILITY CATEGORY 5

              WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
              CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
 DIRECTION   (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
(DEGREES)
      .000     .00000000    .00446430    .01293501    .00000000    .00000000    .00000000
    22.500     .00000000    .00320510    .00972991    .00000000    .00000000    .00000000
    45.000     .00000000    .00251830    .00709710    .00000000    .00000000    .00000000
    67.500     .00000000    .00331960    .00961540    .00000000    .00000000    .00000000
    90.000     .00000000    .00469320    .01098901    .00000000    .00000000    .00000000
   112.500     .00000000    .00240380    .00881410    .00000000    .00000000    .00000000
   135.000     .00000000    .00183150    .00423530    .00000000    .00000000    .00000000
   157.500     .00000000    .00251830    .00251830    .00000000    .00000000    .00000000
   180.000     .00000000    .00251830    .00125920    .00000000    .00000000    .00000000
   202.500     .00000000    .00148810    .00148810    .00000000    .00000000    .00000000
   225.000     .00000000    .00183150    .00160260    .00000000    .00000000    .00000000
   247.500     .00000000    .00297620    .00572340    .00000000    .00000000    .00000000
   270.000     .00000000    .00572340    .01064561    .00000000    .00000000    .00000000
   292.500     .00000000    .00412090    .00755490    .00000000    .00000000    .00000000
   315.000     .00000000    .00297620    .00572340    .00000000    .00000000    .00000000
   337.500     .00000000    .00423530    .00950090    .00000000    .00000000    .00000000
                                              SEASON 4
                                        STABILITY CATEGORY 6

              WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
              CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
 DIRECTION   (  .7500MPS)( 2.5000MPS)( 4.3000MPS)( 6.8000MPS)( 9.5000MPS)(12.5000MPS)
(DEGREES)
      .000     .00530460    .01030221    .00000000    .00000000    .00000000    .00000000
    22.500     .00397630    .00549450    .00000000    .00000000    .00000000    .00000000
    45.000     .00268210    .00412090    .00000000    .00000000    .00000000    .00000000
    67.500     .00427810    .00812730    .00000000    .00000000    .00000000    .00000000
    90.000     .00547310    .01293501    .00000000    .00000000    .00000000    .00000000
   112.500     .00317500    .00629580    .00000000    .00000000    .00000000    .00000000
   135.000     .00336980    .00263280    .00000000    .00000000    .00000000    .00000000
   157.500     .00371230    .00309070    .00000000    .00000000    .00000000    .00000000
   180.000     .00413140    .00320510    .00000000    .00000000    .00000000    .00000000
   202.500     .00512000    .00515110    .00000000    .00000000    .00000000    .00000000
   225.000     .00327240    .00446430    .00000000    .00000000    .00000000    .00000000
   247.500     .00524600    .01156141    .00000000    .00000000    .00000000    .00000000
   270.000     .01450371    .02770151    .00000000    .00000000    .00000000    .00000000
   292.500     .00732070    .01362181    .00000000    .00000000    .00000000    .00000000
   315.000     .00644840    .00995881    .00000000    .00000000    .00000000    .00000000
   337.500     .00890250    .01350731    .00000000    .00000000    .00000000    .00000000
```

FIGURE 4-2. (Continued)

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**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE     15 ****

                                      - ISCLT INPUT DATA (CONT.) -

                         - VERTICAL POTENTIAL TEMPERATURE GRADIENT (DEGREES KELVIN/METER) -

                       WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                       CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
STABILITY CATEGORY 1   .000000      .000000      .000000      .000000      .000000      .000000
STABILITY CATEGORY 2   .000000      .000000      .000000      .000000      .000000      .000000
STABILITY CATEGORY 3   .000000      .000000      .000000      .000000      .000000      .000000
STABILITY CATEGORY 4   .000000      .000000      .000000      .000000      .000000      .000000
STABILITY CATEGORY 5   .200000-01   .200000-01   .200000-01   .200000-01   .200000-01   .200000-01
STABILITY CATEGORY 6   .350000-01   .350000-01   .350000-01   .350000-01   .350000-01   .350000-01
                                      - WIND PROFILE POWER LAW EXPONENTS -

                       WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED   WIND SPEED
                       CATEGORY 1   CATEGORY 2   CATEGORY 3   CATEGORY 4   CATEGORY 5   CATEGORY 6
STABILITY CATEGORY 1   .100000+00   .100000+00   .100000+00   .100000+00   .100000+00   .100000+00
STABILITY CATEGORY 2   .150000+00   .150000+00   .150000+00   .150000+00   .150000+00   .150000+00
STABILITY CATEGORY 3   .200000+00   .200000+00   .200000+00   .200000+00   .200000+00   .200000+00
STABILITY CATEGORY 4   .250000+00   .250000+00   .250000+00   .250000+00   .250000+00   .250000+00
STABILITY CATEGORY 5   .300000+00   .300000+00   .300000+00   .300000+00   .300000+00   .300000+00
STABILITY CATEGORY 6   .300000+00   .300000+00   .300000+00   .300000+00   .300000+00   .300000+00
```

FIGURE 4-2. (Continued)

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**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                        ******** PAGE    16 ****

                                              - SOURCE INPUT DATA -

C T SOURCE SOURCE      X           Y    EMISSION   BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE  HEIGHT  ELEV- /              - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)         (M)         (M)  ATION /
D E                                                (M)  /
--------------------------------------------------------------------------------------------------------------------------
X        1  AREA        -13.30      -13.30   10.00     .00 WIDTH OF AREA (M)=   26.60
                                                                                - PARTICULATE CATEGORIES -
                                                                                   1     2      3     4      5     6
                                                         FALL VELOCITY (MPS)     .0010 .0070  .0190 .0370  .0610 .0990
                                                         MASS FRACTION           .1000 .4000  .2800 .1200  .0600 .0400
                                                         REFLECTION COEFFICIENT 1.0000 .8200  .7200 .6500  .5900 .5000
                                                               - SOURCE STRENGTHS ( GRAMS PER SEC  PER SQUARE METER          ) -
                                                                                         - SEASON 1 -
                                       SPEED CATEGORY                            - STABILITY CATEGORIES -
                                                          (1)         (2)         (3)          (4)         (5)         (6)
                                               1       4.00000-01  3.00000-01   2.00000-01  1.00000-01  0.00000      5.00000-02
                                               2       5.00000-01  4.00000-01   3.00000-01  2.50000-01  2.00000-01   1.00000-01
                                               3       0.00000     5.00000-01   4.00000-01  5.00000-01  2.50000-01   0.00000
                                               4       0.00000     0.00000      5.00000-01  5.00000-01  0.00000      0.00000
                                               5       0.00000     0.00000      7.00000-01  7.00000-01  0.00000      0.00000
                                               6       0.00000     0.00000      1.00000+00  1.00000+00  0.00000      0.00000
                                                                                         - SEASON 2 -
                                       SPEED CATEGORY                            - STABILITY CATEGORIES -
                                                          (1)         (2)         (3)          (4)         (5)         (6)
                                               1       4.00000-01  3.00000-01   2.00000-01  1.00000-01  0.00000      5.00000-02
                                               2       5.00000-01  4.00000-01   3.00000-01  2.50000-01  2.00000-01   1.00000-01
                                               3       0.00000     5.00000-01   4.00000-01  5.00000-01  2.50000-01   0.00000
                                               4       0.00000     0.00000      5.00000-01  5.00000-01  0.00000      0.00000
                                               5       0.00000     0.00000      7.00000-01  7.00000-01  0.00000      0.00000
                                               6       0.00000     0.00000      1.00000+00  1.00000+00  0.00000      0.00000
                                                                                         - SEASON 3 -
                                       SPEED CATEGORY                            - STABILITY CATEGORIES -
                                                          (1)         (2)         (3)          (4)         (5)         (6)
                                               1       4.00000-01  3.00000-01   2.00000-01  1.00000-01  0.00000      5.00000-02
                                               2       5.00000-01  4.00000-01   3.00000-01  2.50000-01  2.00000-01   1.00000-01
                                               3       0.00000     5.00000-01   4.00000-01  5.00000-01  2.50000-01   0.00000
                                               4       0.00000     0.00000      5.00000-01  5.00000-01  0.00000      0.00000
                                               5       0.00000     0.00000      7.00000-01  7.00000-01  0.00000      0.00000
                                               6       0.00000     0.00000      1.00000+00  1.00000+00  0.00000      0.00000
                                                                                         - SEASON 4 -
                                       SPEED CATEGORY                            - STABILITY CATEGORIES -
                                                          (1)         (2)         (3)          (4)         (5)         (6)
                                               1       4.00000-01  3.00000-01   2.00000-01  1.00000-01  0.00000      5.00000-02
                                               2       5.00000-01  4.00000-01   3.00000-01  2.50000-01  2.00000-01   1.00000-01
                                               3       0.00000     5.00000-01   4.00000-01  5.00000-01  2.50000-01   0.00000
                                               4       0.00000     0.00000      5.00000-01  5.00000-01  0.00000      0.00000
                                               5       0.00000     0.00000      7.00000-01  7.00000-01  0.00000      0.00000
                                               6       0.00000     0.00000      1.00000+00  1.00000+00  0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE       1 AND POINT X,Y=      .00,        .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. Example listing of input sources used in the calculation of seasonal and annual ground-level particulate concentration from a hypothetical potash processing plant.

```
**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE     17 ****

                                                  - SOURCE INPUT DATA -

C T SOURCE SOURCE      X            Y         EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE   COORDINATE   HEIGHT  ELEV- /                    - SOURCE DETAILS DEPENDING ON TYPE -
R P                   (M)          (M)        (M)   ATION /
D E                                                  (M)  /
------------------------------------------------------------------------------------------------------------------------
X        2 VOLUME       20.00          .00      .90      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                             STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                                 - PARTICULATE CATEGORIES -
                                                                                1      2      3      4      5      6
                                                             FALL VELOCITY (MPS)      .0010  .0070  .0190  .0370  .0610  .0990
                                                             MASS FRACTION            .1000  .4000  .2800  .1200  .0600  .0400
                                                             REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                          ) -
                                                                                       - SEASON 1 -
                                    SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)           (2)          (3)          (4)          (5)          (6)
                                          1       1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2       1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3       0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4       0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5       0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6       0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                       - SEASON 2 -
                                    SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)           (2)          (3)          (4)          (5)          (6)
                                          1       1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2       1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3       0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4       0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5       0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6       0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                       - SEASON 3 -
                                    SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)           (2)          (3)          (4)          (5)          (6)
                                          1       1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2       1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3       0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4       0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5       0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6       0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                       - SEASON 4 -
                                    SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)           (2)          (3)          (4)          (5)          (6)
                                          1       1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2       1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3       0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4       0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5       0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6       0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE      2 AND POINT X,Y=        .00,          .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************                 HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE    18 ****

                                                   - SOURCE INPUT DATA -

C T SOURCE SOURCE      X           Y       EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE  HEIGHT   ELEV- /                    - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)         (M)        (M)    ATION /
D E                                                 (M)  /
-------------------------------------------------------------------------------------------------------------------------------
X        3 VOLUME       30.00         .00   2.60      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                          STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                             - PARTICULATE CATEGORIES -
                                                                             1      2      3      4      5      6
                                                          FALL VELOCITY (MPS)      .0010  .0070  .0190  .0370  .0610  .0990
                                                          MASS FRACTION            .1000  .4000  .2800  .1200  .0600  .0400
                                                          REFLECTION COEFFICIENT 1.0000   .8200  .7200  .6500  .5900  .5000
                                                               - SOURCE STRENGTHS ( GRAMS PER SEC                           ) -
                                                                                     - SEASON 1 -
                                           SPEED CATEGORY                     - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                  1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                     - SEASON 2 -
                                           SPEED CATEGORY                     - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                  1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                     - SEASON 3 -
                                           SPEED CATEGORY                     - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                  1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                     - SEASON 4 -
                                           SPEED CATEGORY                     - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                  1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE      3 AND POINT X,Y=        .00,        .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************              HYPOTHETICAL POTASH PROCESSING PLANT                     ******** PAGE    19 ****

                                               - SOURCE INPUT DATA -

C T SOURCE SOURCE      X           Y        EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE   HEIGHT   ELEV- /                - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)         (M)         (M)    ATION /
D E                                                  (M)  /
------------------------------------------------------------------------------------------------------------------------
X        4 VOLUME      40.00          .00    4.30      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                            STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                                   - PARTICULATE CATEGORIES -
                                                                                 1      2      3      4      5      6
                                                           FALL VELOCITY (MPS)    .0010  .0070  .0190  .0370  .0610  .0990
                                                           MASS FRACTION          .1000  .4000  .2000  .1200  .0600  .0400
                                                           REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                 - SOURCE STRENGTHS ( GRAMS PER SEC                        ) -
                                                                                        - SEASON 1 -
                                          SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                          (1)          (2)          (3)          (4)          (5)          (6)
                                                  1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                        - SEASON 2 -
                                          SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                          (1)          (2)          (3)          (4)          (5)          (6)
                                                  1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                        - SEASON 3 -
                                          SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                          (1)          (2)          (3)          (4)          (5)          (6)
                                                  1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                        - SEASON 4 -
                                          SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                          (1)          (2)          (3)          (4)          (5)          (6)
                                                  1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                  2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                  3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                  4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                  5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                  6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE      4 AND POINT X,Y=        .00,        .00 IS LESS THAN PERMITTED
```

FIGURE 4-3.   (Continued)

```
**** ISCLT *************                 HYPOTHETICAL POTASH PROCESSING PLANT                                   ******** PAGE    20 ****

                                                   - SOURCE INPUT DATA -

C T SOURCE SOURCE     X           Y        EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE  HEIGHT  ELEV- /                  - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)         (M)        (M)   ATION /
D E                                                (M)  /
------------------------------------------------------------------------------------------------------------------------------
X        5 VOLUME      49.00         .00    6.10     .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                         STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                             - PARTICULATE CATEGORIES -
                                                                            1       2       3       4       5       6
                                                         FALL VELOCITY (MPS)      .0010   .0070   .0190   .0370   .0610   .0990
                                                         MASS FRACTION            .1000   .4000   .2800   .1200   .0600   .0400
                                                         REFLECTION COEFFICIENT 1.0000   .8200   .7200   .6500   .5900   .5000
                                                               - SOURCE STRENGTHS ( GRAMS PER SEC                            ) -
                                                                                    - SEASON 1 -
                                    SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                   (1)          (2)          (3)          (4)          (5)          (6)
                                          1    1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2    1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3    0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4    0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5    0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6    0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                    - SEASON 2 -
                                    SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                   (1)          (2)          (3)          (4)          (5)          (6)
                                          1    1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2    1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3    0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4    0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5    0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6    0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                    - SEASON 3 -
                                    SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                   (1)          (2)          (3)          (4)          (5)          (6)
                                          1    1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2    1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3    0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4    0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5    0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6    0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                    - SEASON 4 -
                                    SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                   (1)          (2)          (3)          (4)          (5)          (6)
                                          1    1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                          2    1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                          3    0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                          4    0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                          5    0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                          6    0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE     5 AND POINT X,Y=          .00,         .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************                    HYPOTHETICAL POTASH PROCESSING PLANT                                  ******** PAGE    21 ****

                                                        - SOURCE INPUT DATA -

C I SOURCE SOURCE      X           Y       EMISSION  BASE /
A A NUMBER  TYPE   COORDINATE  COORDINATE   HEIGHT   ELEV- /
R P                   (M)         (M)        (M)     ATION /                  - SOURCE DETAILS DEPENDING ON TYPE -
D E                                                  (M)  /
------------------------------------------------------------------------------------------------------------------------------------
X         6 VOLUME      59.00          .00   7.80       .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                            STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                                - PARTICULATE CATEGORIES -
                                                                              1      2      3      4      5      6
                                                            FALL VELOCITY (MPS)     .0010  .0070  .0190  .0370  .0610  .0990
                                                            MASS FRACTION           .1000  .4000  .2800  .1200  .0600  .0400
                                                            REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                               ) -
                                                                                             - SEASON 1 -
                                             SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                    1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                    2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                    3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                    4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                    5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                    6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                             - SEASON 2 -
                                             SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                    1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                    2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                    3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                    4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                    5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                    6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                             - SEASON 3 -
                                             SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                    1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                    2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                    3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                    4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                    5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                    6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                             - SEASON 4 -
                                             SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                            (1)          (2)          (3)          (4)          (5)          (6)
                                                    1   1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                                    2   1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                                    3   0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                                    4   0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                                    5   0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                                    6   0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE      6 AND POINT X,Y=          .00,          .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE     22 ****

                                                   - SOURCE INPUT DATA -

C T SOURCE SOURCE      X             Y        EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE   COORDINATE   HEIGHT  ELEV- /                  - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)           (M)         (M)  ATION /
D E                                                  (M)  /
------------------------------------------------------------------------------------------------------------------------------
X        7 VOLUME      69.00            .00    9.60     .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                            STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                                 - PARTICULATE CATEGORIES -
                                                                                 1      2      3      4      5      6
                                                            FALL VELOCITY (MPS)      .0010  .0070  .0190  .0370  .0610  .0990
                                                            MASS FRACTION            .1000  .4000  .2800  .1200  .0600  .0400
                                                            REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                 - SOURCE STRENGTHS ( GRAMS PER SEC                            ) -
                                                                                       - SEASON 1 -
                                        SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                      (1)           (2)           (3)           (4)           (5)           (6)
                                               1   1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                               2   1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                               3   0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                               4   0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                               5   0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                               6   0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
                                                                                       - SEASON 2 -
                                        SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                      (1)           (2)           (3)           (4)           (5)           (6)
                                               1   1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                               2   1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                               3   0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                               4   0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                               5   0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                               6   0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
                                                                                       - SEASON 3 -
                                        SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                      (1)           (2)           (3)           (4)           (5)           (6)
                                               1   1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                               2   1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                               3   0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                               4   0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                               5   0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                               6   0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
                                                                                       - SEASON 4 -
                                        SPEED CATEGORY                        - STABILITY CATEGORIES -
                                                      (1)           (2)           (3)           (4)           (5)           (6)
                                               1   1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                               2   1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                               3   0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                               4   0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                               5   0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                               6   0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
WARNING - DISTANCE BETWEEN SOURCE      7 AND POINT X,Y=         .00,          .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************             HYPOTHETICAL POTASH PROCESSING PLANT                                  ******** PAGE    23 ****

                                          - SOURCE INPUT DATA -

C T SOURCE SOURCE     X            Y        EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE  HEIGHT   ELEV- /              - SOURCE DETAILS DEPENDING ON TYPE -
R P                   (M)         (M)        (M)    ATION /
D E                                                  (M)  /
---------------------------------------------------------------------------------------------------------------------------------
X        8 VOLUME      79.00          .00  11.30      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                          STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                           - PARTICULATE CATEGORIES -
                                                                             1      2      3      4      5      6
                                                          FALL VELOCITY (MPS)      .0010  .0070  .0190  .0370  .0610  .0990
                                                          MASS FRACTION            .1000  .4000  .2800  .1200  .0600  .0400
                                                          REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                 - SOURCE STRENGTHS ( GRAMS PER SEC                              ) -
                                                                                            - SEASON 1 -
                                       SPEED CATEGORY                                   - STABILITY CATEGORIES -
                                                             (1)           (2)           (3)           (4)           (5)           (6)
                                              1         1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                              2         1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                              3         0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                              4         0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                              5         0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                              6         0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
                                                                                            - SEASON 2 -
                                       SPEED CATEGORY                                   - STABILITY CATEGORIES -
                                                             (1)           (2)           (3)           (4)           (5)           (6)
                                              1         1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                              2         1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                              3         0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                              4         0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                              5         0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                              6         0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
                                                                                            - SEASON 3 -
                                       SPEED CATEGORY                                   - STABILITY CATEGORIES -
                                                             (1)           (2)           (3)           (4)           (5)           (6)
                                              1         1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                              2         1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                              3         0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                              4         0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                              5         0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                              6         0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
                                                                                            - SEASON 4 -
                                       SPEED CATEGORY                                   - STABILITY CATEGORIES -
                                                             (1)           (2)           (3)           (4)           (5)           (6)
                                              1         1.30000-01    1.00000-01    8.00000-02    4.00000-02    0.00000       2.00000-02
                                              2         1.60000-01    1.30000-01    1.20000-01    1.00000-01    8.00000-02    5.00000-02
                                              3         0.00000       1.60000-01    1.40000-01    1.30000-01    1.00000-01    0.00000
                                              4         0.00000       0.00000       1.60000-01    1.60000-01    0.00000       0.00000
                                              5         0.00000       0.00000       1.90000-01    1.90000-01    0.00000       0.00000
                                              6         0.00000       0.00000       2.20000-01    2.20000-01    0.00000       0.00000
WARNING - DISTANCE BETWEEN SOURCE     8 AND POINT X,Y=          .00,          .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************              HYPOTHETICAL POTASH PROCESSING PLANT                         ******** PAGE     24 ****

                                                - SOURCE INPUT DATA -

C T SOURCE SOURCE      X            Y        EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE   COORDINATE   HEIGHT   ELEV- /                   - SOURCE DETAILS DEPENDING ON TYPE -
R P                   (M)          (M)         (M)    ATION /
D E                                                    (M)  /
-----------------------------------------------------------------------------------------------------------------------------
X         9 VOLUME       89.00          .00  13.00       .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                             STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                          - PARTICULATE CATEGORIES -
                                                                           1       2       3       4       5       6
                                                             FALL VELOCITY (MPS)     .0010   .0070   .0190   .0370   .0610   .0990
                                                             MASS FRACTION           .1000   .4000   .2800   .1200   .0600   .0400
                                                             REFLECTION COEFFICIENT 1.0000   .8200   .7200   .6500   .5900   .5000
                                                                  - SOURCE STRENGTHS ( GRAMS PER SEC                                    ) -
                                                                                         - SEASON 1 -
                                                                                - STABILITY CATEGORIES -
                              SPEED CATEGORY                                    (3)          (4)          (5)          (6)
                                                   (1)          (2)
                                    1         1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                    2         1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                    3         0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                    4         0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                    5         0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                    6         0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                         - SEASON 2 -
                                                                                - STABILITY CATEGORIES -
                              SPEED CATEGORY                                    (3)          (4)          (5)          (6)
                                                   (1)          (2)
                                    1         1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                    2         1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                    3         0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                    4         0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                    5         0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                    6         0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                         - SEASON 3 -
                                                                                - STABILITY CATEGORIES -
                              SPEED CATEGORY                                    (3)          (4)          (5)          (6)
                                                   (1)          (2)
                                    1         1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                    2         1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                    3         0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                    4         0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                    5         0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                    6         0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                         - SEASON 4 -
                                                                                - STABILITY CATEGORIES -
                              SPEED CATEGORY                                    (3)          (4)          (5)          (6)
                                                   (1)          (2)
                                    1         1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                    2         1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                    3         0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                    4         0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                    5         0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                    6         0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
 WARNING - DISTANCE BETWEEN SOURCE      9 AND POINT X,Y=        .00,        .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

```
**** ISCLT *************               HYPOTHETICAL POTASH PROCESSING PLANT                         ******** PAGE     25 ****

                                             - SOURCE INPUT DATA -

C T SOURCE SOURCE      X            Y       EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE   HEIGHT  ELEV- /                     - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)          (M)         (M)  ATION /
D E                                                  (M)  /
--------------------------------------------------------------------------------------------------------------------------------
X       10 VOLUME       99.00          .00  14.80      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                           STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                              - PARTICULATE CATEGORIES -
                                                                              1      2      3      4      5      6
                                                           FALL VELOCITY (MPS)      .0010  .0070  .0190  .0370  .0610  .0990
                                                           MASS FRACTION            .1000  .4000  .2800  .1200  .0600  .0400
                                                           REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                - SOURCE STRENGTHS ( GRAMS PER SEC                          ) -
                                                                                        - SEASON 1 -
                                       SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                              1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                              2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                              3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                              4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                              5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                              6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                        - SEASON 2 -
                                       SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                              1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                              2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                              3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                              4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                              5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                              6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                        - SEASON 3 -
                                       SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                              1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                              2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                              3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                              4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                              5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                              6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                        - SEASON 4 -
                                       SPEED CATEGORY                              - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                              1     1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                              2     1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                              3     0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                              4     0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                              5     0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                              6     0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE     10 AND POINT X,Y=        .00,          .00 IS LESS THAN PERMITTED
WARNING - DISTANCE BETWEEN SOURCE     10 AND POINT X,Y=     200.00,          .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

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**** ISCLT *************             HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE    26 ****

                                          - SOURCE INPUT DATA -

C T SOURCE SOURCE      X           Y       EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE   HEIGHT  ELEV- /                  - SOURCE DETAILS DEPENDING ON TYPE -
R P                   (M)         (M)        (M)   ATION /
D E                                                 (M)  /
--------------------------------------------------------------------------------------------------------------------------
X        11 VOLUME      109.00          .00  16.50      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=   4.70
                                                            STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=   1.00
                                                                             - PARTICULATE CATEGORIES -
                                                                              1      2      3      4      5      6
                                                            FALL VELOCITY (MPS)      .0010  .0070  .0190  .0370  .0610  .0990
                                                            MASS FRACTION            .1000  .4000  .2800  .1200  .0600  .0400
                                                            REFLECTION COEFFICIENT 1.0000  .8200  .7200  .6500  .5900  .5000
                                                                  - SOURCE STRENGTHS ( GRAMS PER SEC                            ) -
                                                                                     - SEASON 1 -
                                     SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                            1      1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                            2      1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                            3      0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                            4      0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                            5      0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                            6      0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                     - SEASON 2 -
                                     SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                            1      1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                            2      1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                            3      0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                            4      0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                            5      0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                            6      0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                     - SEASON 3 -
                                     SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                            1      1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                            2      1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                            3      0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                            4      0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                            5      0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                            6      0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
                                                                                     - SEASON 4 -
                                     SPEED CATEGORY                          - STABILITY CATEGORIES -
                                                       (1)          (2)          (3)          (4)          (5)          (6)
                                            1      1.30000-01   1.00000-01   8.00000-02   4.00000-02   0.00000      2.00000-02
                                            2      1.60000-01   1.30000-01   1.20000-01   1.00000-01   8.00000-02   5.00000-02
                                            3      0.00000      1.60000-01   1.40000-01   1.30000-01   1.00000-01   0.00000
                                            4      0.00000      0.00000      1.60000-01   1.60000-01   0.00000      0.00000
                                            5      0.00000      0.00000      1.90000-01   1.90000-01   0.00000      0.00000
                                            6      0.00000      0.00000      2.20000-01   2.20000-01   0.00000      0.00000
WARNING - DISTANCE BETWEEN SOURCE      11 AND POINT X,Y=        .00,        .00 IS LESS THAN PERMITTED
WARNING - DISTANCE BETWEEN SOURCE      11 AND POINT X,Y=     200.00,        .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

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**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                                        ******** PAGE    27 ****

                                                     - SOURCE INPUT DATA -

C T SOURCE SOURCE      X            Y       EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE  HEIGHT  ELEV- /                  - SOURCE DETAILS DEPENDING ON TYPE -
R P                   (M)          (M)        (M)  ATION /
D E                                                 (M)  /
-------------------------------------------------------------------------------------------------------------------------------
X       12 VOLUME       121.00          .00  22.50      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=  10.00
                                                             STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=  11.60
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                         ) -
                                                                          SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                          2.63000+00    2.63000+00    2.63000+00    2.63000+00
WARNING - DISTANCE BETWEEN SOURCE     12 AND POIAT X,Y=       .00,          .00 IS LESS THAN PERMITTED
WARNING - DISTANCE BETWEEN SOURCE     12 AND POINT X,Y=    200.00,          .00 IS LESS THAN PERMITTED
X       13 VOLUME       144.00          .00  22.50      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=  10.00
                                                             STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=  11.60
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                         ) -
                                                                          SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                          2.63000+00    2.63000+00    2.63000+00    2.63000+00
WARNING - DISTANCE BETWEEN SOURCE     13 AND POINT X,Y=    200.00,          .00 IS LESS THAN PERMITTED
X       14 VOLUME       167.00          .00  22.50      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=  10.00
                                                             STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=  11.60
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                         ) -
                                                                          SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                          2.63000+00    2.63000+00    2.63000+00    2.63000+00
WARNING - DISTANCE BETWEEN SOURCE     14 AND POINT X,Y=    200.00,          .00 IS LESS THAN PERMITTED
X       15 VOLUME       190.00          .00  22.50      .00 STANDARD DEVIATION OF THE CROSSWIND SOURCE DISTRIBUTION (M)=  10.00
                                                             STANDARD DEVIATION OF THE VERTICAL SOURCE DISTRIBUTION (M)=  11.60
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                         ) -
                                                                          SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                          2.63000+00    2.63000+00    2.63000+00    2.63000+00
WARNING - DISTANCE BETWEEN SOURCE     15 AND POINT X,Y=    200.00,          .00 IS LESS THAN PERMITTED
X       16  STACK       201.00        30.00  50.00      .00 GAS EXIT TEMP (DEG K)= 340.00, GAS EXIT VEL. (M/SEC)=  0.00,
                                                             STACK DIAMETER (M)= 1.000, HEIGHT OF ASSO. BLDG. (M)= 25.00, WIDTH OF
                                                             ASSO. BLDG. (M)=  67.00, WAKE EFFECTS FLAG = 0
                                                                   - SOURCE STRENGTHS ( GRAMS PER SEC                         ) -
                                                                          SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                          5.00000+00    5.00000+00    5.00000+00    5.00000+00
WARNING - DISTANCE BETWEEN SOURCE     16 AND POINT X,Y=    200.00,          .00 IS LESS THAN PERMITTED
```

FIGURE 4-3. (Continued)

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**** ISCLT *************                    HYPOTHETICAL POTASH PROCESSING PLANT                         ********* PAGE     28 ****

      ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER            ) DUE TO SOURCE      1           **
                                                                    SEASON  1
                                                              - GRID SYSTEM RECEPTORS -
                                                         .  - X AXIS (DISTANCE, METERS) -
                  -3000.000     -2000.000     -1500.000     -1250.000     -1000.000      -800.000      -600.000      -400.000      -200.000
 Y AXIS (DISTANCE         , METERS  )                                   -  CONCENTRATION  -
                 -------------------------------------------------------------------------------------------------------------------

      3000.000     13.616997     16.810891     18.356266     19.233525     19.902356     20.625919     21.201759     21.602884     21.798932
      2000.000     22.783020     27.584421     32.063393     34.803720     37.188672     38.839573     41.300342     43.286392     44.461175
      1500.000     29.018424     40.117167     45.781192     49.558081     55.845340     60.434878     65.060946     69.784248     73.490338
      1250.000     33.007664     48.404156     57.812235     63.220872     69.673079     77.946795     85.153463     93.095447    100.430190
      1000.000     34.582721     57.747243     74.426943     83.335948     93.921556    102.198080    117.300496    134.405924    145.771563
       800.000     35.830785     66.203685     89.938190    105.563027    122.058452    139.302376    154.884851    182.647335    211.396776
       600.000     36.828998     70.299512    108.800716    131.331247    162.619848    191.393314    233.914997    271.919285    331.568481
       400.000     37.531672     73.502182    116.706080    154.427860    218.199671    270.731171    355.318420    485.499912    588.287308
       200.000     37.884810     75.335793    122.261150    165.231693    236.824535    341.535160    533.659660    848.470459   1483.300430
          .000     38.403270     77.141260    126.762945    173.267048    253.221277    375.338619    617.214340   1190.316284   2911.119293
      -200.000     35.176148     67.437188    105.646628    138.851784    190.945866    261.589985    375.357651    513.585052   1021.508537
      -400.000     32.602053     59.442345     87.891022    109.718848    141.718382    168.018717    223.655920    343.197296    658.447624
      -600.000     29.852404     50.978420     70.207855     81.918691    102.938817    123.252440    165.759817    270.985909    478.198792
      -800.000     27.005841     42.575752     56.716330     67.576478     79.861310     98.817122    144.096085    218.350760    324.332962
     -1000.000     24.129535     36.353679     48.031611     54.884416     66.742523     91.234782    128.924860    188.122856    233.356602
     -1250.000     20.791437     31.182077     38.503721     44.997336     62.728845     83.449615    108.471891    141.814390    168.141409
     -1500.000     18.374005     26.488539     32.641378     43.251008     50.729640     73.710485     94.740171    111.481556    127.242635
     -2000.000     14.915928     19.748687     31.135496     39.033751     48.225537     58.026190     66.098783     73.866708     88.774837
     -3000.000      9.816567     18.381877     24.559273     28.731543     32.072045     34.796732     37.407102     39.835498     41.999429

                                                              - GRID SYSTEM RECEPTORS -
                                                            - X AXIS (DISTANCE, METERS) -
                       .000       200.000       400.000       600.000       800.000      1000.000      1250.000      1500.000      2000.000
 Y AXIS (DISTANCE         , METERS  )                                   -  CONCENTRATION  -
                 -------------------------------------------------------------------------------------------------------------------

      3000.000     22.170279     20.875027     19.920651     18.819462     17.610409     16.326848     14.895370     13.670574     11.803912
      2000.000     45.868863     41.856510     38.644834     34.909380     30.970592     27.965487     25.024716     22.158577     18.056702
      1500.000     77.124822     68.140335     60.486155     52.320283     45.201609     39.892694     33.651000     30.263329     30.426548
      1250.000    107.035131     92.064947     78.874166     65.269887     56.449784     48.023100     42.110441     42.091849     39.002230
      1000.000    159.453207    131.491547    109.295262     86.551263     70.872977     63.202829     62.017409     58.945675     49.101901
       800.000    239.530056    186.776987    139.829491    109.566168     94.701244     91.193011     84.789304     75.496819     63.196101
       600.000    401.208195    283.424896    197.104128    160.666399    146.742023    132.968700    112.697596    104.952324     83.741148
       400.000    798.079964    447.284042    336.679783    279.902290    229.160326    213.885267    178.604877    148.783318    105.181254
       200.000   2099.566315   1022.300316    650.020973    606.986130    447.874649    337.795872    251.546938    194.377935    126.469180
          .000       .000000   4705.437866   2133.509735   1146.510666    710.003708    484.540318    334.176414    245.722200    150.471292
      -200.000   2895.978912   1839.577164   1184.709595    840.983459    569.264534    408.760803    293.177822    220.993895    139.397350
      -400.000   1287.537979    804.960754    655.048500    503.677750    395.472507    334.057091    249.533657    195.132414    128.261654
      -600.000    683.794754    507.234932    382.317074    322.824516    272.997986    237.319185    195.228205    167.498585    115.559818
      -800.000    420.558243    340.344494    267.396671    219.996414    194.386766    174.562572    154.444038    133.593345    102.259296
     -1000.000    285.791199    242.878387    207.017883    171.755058    145.898260    131.875456    119.899905    109.056379     86.635903
     -1250.000    196.919363    173.398451    150.734020    128.688354    114.713129    100.276953     89.183467     83.194344     71.733726
     -1500.000    144.806110    130.391167    116.957111    102.635981     91.258114     82.431523     71.385410     64.828494     58.701031
     -2000.000     88.782019     82.115747     76.275244     69.428605     62.173826     57.293200     52.339115     47.226230     39.336248
```

FIGURE 4-4. Example listing of seasonal ground-level particulate concentration for the winter season due to a single source.

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**** ISCLT *************                   HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE    29 ****

     ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER          ) DUE TO SOURCE     1 (CONT.) **
                                                          SEASON  1
                                                  - GRID SYSTEM RECEPTORS -
                                                - X AXIS (DISTANCE, METERS) -
                       .000      200.000      400.000      600.000      800.000     1000.000     1250.000     1500.000     2000.000
Y AXIS (DISTANCE      , METERS  )                          -  CONCENTRATION  -
        ------------------------------------------------------------------------------------------------------------------------

   -3000.000      44.652255    42.406554    40.588500    38.483091    36.162366    33.686798    30.993699    28.829953    25.485259

                                                  - GRID SYSTEM RECEPTORS -
                                                - X AXIS (DISTANCE, METERS) -
                     3000.000
Y AXIS (DISTANCE      , METERS  )                          -  CONCENTRATION  -
        ------------------------------------------------------------------------------------------------------------------------

    3000.000       8.792341
    2000.000      17.951743
    1500.000      24.667804
    1250.000      29.661916
    1000.000      38.219460
     800.000      45.451096
     600.000      52.826692
     400.000      60.194146
     200.000      67.370555
        .000      75.538429
    -200.000      71.948288
    -400.000      68.541867
    -600.000      64.663849
    -800.000      60.453549
   -1000.000      56.023649
   -1250.000      50.673500
   -1500.000      43.967046
   -2000.000      33.959895
   -3000.000      19.592829
      ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER          ) DUE TO SOURCE     1 (CONT.) **
                                                          SEASON  1
                                                    - DISCRETE RECEPTORS -
    X          Y       CONCENTRATION         X          Y      CONCENTRATION          X          Y      CONCENTRATION
  RANGE     AZIMUTH                        RANGE     AZIMUTH                        RANGE     AZIMUTH
            BEARING                                  BEARING                                  BEARING
 (METERS) (DEGREES)                       (METERS) (DEGREES)                       (METERS) (DEGREES)
        ------------------------------------------------------------------------------------------------------------------------

   2108.0        14.0     35.419290
```

FIGURE 4-4. (Continued)

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**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                         ******** PAGE    30 ****

        ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER            ) DUE TO SOURCE      1 (CONT.)  **
                                                   SEASON  1
                 - 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF COMBINED SOURCES       1.

                                            X           Y        CONCENTRATION
                                        COORDINATE  COORDINATE


                                         (METERS)    (METERS )
                                        ------------------------------------
                                            200.00         .00     4705.437066
                                           -200.00         .00     2911.119293
                                               .00     -200.00     2895.970912
                                            400.00         .00     2133.509735
                                               .00      200.00     2099.566315
                                            200.00     -200.00     1839.577164
                                           -200.00      200.00     1483.300430
                                               .00     -400.00     1287.537979
                                           -400.00         .00     1190.316284
                                            400.00     -200.00     1184.709595
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FIGURE 4-4. (Continued)

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**** ISCLT *************                      HYPOTHETICAL POTASH PROCESSING PLANT                                  ********* PAGE    40 ****

     **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER              ) DUE TO SOURCE      1 (CONT.)  **
                                                              - GRID SYSTEM RECEPTORS -
                                                            - X AXIS (DISTANCE, METERS) -
                      -3000.000     -2000.000     -1500.000     -1250.000     -1000.000      -800.000      -600.000      -400.000      -200.000
 Y AXIS (DISTANCE          , METERS  )                                      -  CONCENTRATION  -
                ------------------------------------------------------------------------------------------------------------------------------

      3000.000     15.221634     18.578736     20.100570     20.916141     21.395505     21.979454     22.384767     22.584387     22.548849
      2000.000     25.085996     30.903884     35.708897     38.574826     40.968453     42.357633     44.461069     45.964445     46.507261
      1500.000     31.701158     44.375030     51.421357     55.544628     62.251292     66.999136     71.291860     75.116460     77.626460
      1250.000     35.923954     53.192155     64.341074     71.112044     78.188807     87.078055     94.562616    101.360938    107.010847
      1000.000     37.762331     63.033959     82.023768     92.643948    105.893936    115.192478    131.645319    148.986237    157.360858
       800.000     39.246249     71.957653     98.347252    116.238378    135.981600    157.633930    175.535542    206.143169    231.811277
       600.000     40.464014     76.752864    118.199650    143.208109    178.931519    213.219812    266.412334    311.423767    372.564270
       400.000     41.363567     80.610635    127.492531    168.303101    237.375757    296.659161    395.794228    560.169212    691.885910
       200.000     41.883075     82.992779    134.343468    181.328331    259.555923    373.962715    583.919617    943.486504   1788.054550
          .000     42.575230     85.331429    140.035275    191.339746    279.630653    414.663986    682.840363   1322.692307   3285.677673
      -200.000     38.907401     74.361470    116.238572    152.606949    209.613203    286.837337    410.882469    561.938073   1131.299973
      -400.000     35.951738     65.257847     96.119875    119.670203    153.973127    182.560459    244.201986    375.624714    704.935677
      -600.000     32.808560     55.661160     76.149775     88.827738    111.977972    134.531500    181.123684    290.690125    493.750008
      -800.000     29.565277     46.157100     61.585695     73.581216     87.279699    108.045788    155.002468    231.920065    330.110431
     -1000.000     26.295826     39.443785     52.363287     60.028022     73.091817     98.447317    137.456411    196.050786    235.508881
     -1250.000     22.509092     33.976512     42.202484     49.383746     67.732247     89.148383    114.847367    146.138521    168.744806
     -1500.000     19.944837     28.989935     35.893151     46.869015     62.862158     78.248160     99.162294    113.882483    127.248291
     -2000.000     16.301520     21.779318     33.561337     41.690830     51.097478     60.774473     67.980672     74.729506     80.482697
     -3000.000     10.872121     19.715408     26.030627     30.247538     33.230254     35.649734     37.919664     39.976707     41.744378

                                                              - GRID SYSTEM RECEPTORS -
                                                            - X AXIS (DISTANCE, METERS) -
                           .000       200.000       400.000       600.000       800.000      1000.000      1250.000      1500.000      2000.000
 Y AXIS (DISTANCE          , METERS  )                                      -  CONCENTRATION  -
                ------------------------------------------------------------------------------------------------------------------------------

      3000.000     22.657472     21.218081     20.168184     18.971946     17.669779     16.296588     14.722542     13.296584     11.154195
      2000.000     47.136497     42.625257     39.074873     35.011655     30.759928     27.191171     23.811023     20.651116     16.103241
      1500.000     79.611476     69.443008     60.974909     51.992751     43.696829     37.710334     30.972582     26.983356     25.902085
      1250.000    111.011121     93.974270     79.355749     63.759502     53.646960     44.460725     37.541022     36.326882     32.685589
      1000.000    166.622452    134.553356    109.216183     83.036954     65.771640     56.379041     53.320559     49.789945     40.607458
       800.000    252.719282    191.737871    137.116941    102.937274     84.658281     78.580712     71.570762     62.894690     51.197633
       600.000    429.969204    292.120224    189.494501    144.423738    126.216530    112.244652     93.723008     85.297768     65.943861
       400.000    882.005074    451.004166    306.773682    240.616259    192.864162    174.839846    142.180569    116.746348     81.203523
       200.000   2501.452545    977.209450    595.886497    490.390499    353.894108    263.703430    194.335102    149.131149     96.188814
          .000       .000000   3782.151978   1651.689728    878.036613    540.992012    368.016090    252.794506    185.333508    113.034963
      -200.000   2866.782501   1492.697021    900.438637    633.178192    428.426228    307.455807    220.115461    165.665569    104.253480
      -400.000   1257.601929    706.441254    519.629356    383.528786    297.078926    249.244905    186.147055    145.559612     95.607776
      -600.000    666.668350    469.150101    323.227493    254.241194    208.353203    178.888888    145.639702    124.249961     85.812425
      -800.000    410.042606    318.458824    234.122231    182.355068    152.502733    133.417093    116.459707     99.813966     75.608726
     -1000.000    278.772209    229.032652    187.669189    146.918722    119.445587    103.217141     91.493530     82.268517     64.417455
     -1250.000    192.320225    164.708893    139.282814    113.341066     97.180909     81.968684     69.678401     63.597370     53.830546
     -1500.000    141.593710    124.527439    109.166704     93.141042     79.335021     69.384761     57.878736     50.589996     44.492540
     -2000.000     87.002696     79.028723     72.157465     64.455022     56.492001     50.292008     44.496250     38.968336     30.646975
     -3000.000     43.902699     41.182540     38.963737     36.493826     33.849191     31.093420     27.958133     25.345855     21.445036
```

FIGURE 4-5. Example listing of annual ground-level concentration due to a single source.

```
**** ISCLT *************                 HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE     41 ****

       **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER           ) DUE TO SOURCE      1 (CONT.) **
                                                  - GRID SYSTEM RECEPTORS -
                                               - X AXIS (DISTANCE, METERS) -
                     3000 000
Y AXIS (DISTANCE          , METERS  )                        - CONCENTRATION  -
             -------------------------------------------------------------------------------------------------------------

      3000 000       7.856293
      2000 000      15.064934
      1500 000      20.289668
      1250 000      24.110267
      1000 000      30.206484
       800 000      35.357987
       600 000      40.579629
       400 000      45.760097
       200 000      50.766263
           000      56.472849
      -200 000      53.638114
      -400 000      50.998768
      -600 000      48.010376
      -800 000      44.778276
     -1000 000      41.388979
     -1250 000      37.335234
     -1500 000      32.581869
     -2000 000      25.498223
     -3000 000      15.234725
       **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER           ) DUE TO SOURCE      1 (CONT.) **
                                                   - DISCRETE RECEPTORS -
   X         Y        CONCENTRATION          X          Y       CONCENTRATION              X         Y       CONCENTRATION
 RANGE    AZIMUTH                          RANGE    AZIMUTH                              RANGE    AZIMUTH
          BEARING                                   BEARING                                       BEARING
(METERS) (DEGREES)                        (METERS) (DEGREES)                            (METERS) (DEGREES)
             -------------------------------------------------------------------------------------------------------------

  2108.0        14.0     35.667695
               - 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF COMBINED SOURCES      1.

                                      X           Y         CONCENTRATION
                                  COORDINATE  COORDINATE

                                   (METERS)    (METERS )
                                  ------------------------------------
                                     200.00         .00    3782.151978
                                    -200.00         .00    3285.677673
                                        .00     -200.00    2866.782501
                                        .00      200.00    2501.452545
                                    -200.00      200.00    1780.054550
                                     400.00         .00    1651.689728
                                     200.00     -200.00    1492.697021
                                    -400.00         .00    1322.692307
```

FIGURE 4-5. (Continued)

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**** ISCLT *************                  HYPOTHETICAL POTASH PROCESSING PLANT                        ******** PAGE     42 ****

     **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER            ) DUE TO SOURCE      1 (CONT. ) **
              - 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF COMBINED SOURCES      1,

                                     X            Y        CONCENTRATION
                                 COORDINATE   COORDINATE

                                  (METERS)     (METERS )
                                 ------------------------------------
                                        .00      -400.00     1257.601929
                                    -200.00      -200.00     1131.299973
```

FIGURE 4-5. (Continued)

```
**** ISCLT *************            HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE    52 ****

   ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER          ) DUE TO SOURCE     2 (CONT.)  **
                                                            SEASON  4
                                                      - GRID SYSTEM RECEPTORS -
                                                   - X AXIS (DISTANCE, METERS) -
                 -3000.000   -2000.000   -1500.000   -1250.000   -1000.000    -800.000    -600.000    -400.000    -200.000
Y AXIS (DISTANCE         , METERS  )                 -  CONCENTRATION  -
       ------------------------------------------------------------------------------------------------------------------

    3000.000      .007545     .009437     .010349     .010712     .011018     .011246     .011377     .011399     .011298
    2000.000      .012822     .015294     .018068     .019688     .021128     .022306     .022897     .023495     .023584
    1500.000      .016355     .022598     .025397     .028002     .031728     .034511     .037716     .038716     .039707
    1250.000      .018687     .027259     .032686     .035077     .039556     .044538     .049014     .052489     .055049
    1000.000      .019717     .032494     .041999     .047244     .052161     .058419     .067733     .077849     .081586
     800.000      .020600     .037329     .050652     .059693     .069606     .077588     .089619     .107168     .120812
     600.000      .021356     .040189     .061015     .074018     .092344     .110026     .130654     .161237     .197886
     400.000      .021955     .042574     .067066     .088319     .121948     .153685     .206428     .277712     .378408
     200.000      .022367     .044233     .071534     .096556     .138366     .198656     .312275     .529545     .979780
        .000      .022879     .045906     .075481     .103384     .151697     .225019     .375235     .766300    2.440995
    -200.000      .021012     .040299     .063263     .083399     .115359     .158264     .230160     .344057     .661372
    -400.000      .019422     .035377     .052315     .065386     .083506     .100018     .135009     .190458     .370772
    -600.000      .017736     .030200     .041239     .048286     .060845     .073194     .090610     .144347     .245294
    -800.000      .015997     .025074     .033274     .039652     .046913     .054353     .076512     .112451     .158423
   -1000.000      .014248     .021307     .028082     .032065     .036836     .048672     .066695     .094156     .111806
   -1250.000      .012276     .018221     .022423     .024967     .033410     .043163     .054804     .068924     .079132
   -1500.000      .010762     .015435     .018211     .023216     .030442     .037348     .047410     .053293     .059254
   -2000.000      .008702     .011110     .016421     .020042     .024198     .028702     .031672     .034677     .037212
   -3000.000      .005576     .009512     .012273     .013881     .015433     .016515     .017526     .018437     .019215

                                                      - GRID SYSTEM RECEPTORS -
                                                   - X AXIS (DISTANCE, METERS) -
                     .000     200.000     400.000     600.000     800.000    1000.000    1250.000    1500.000    2000.000
Y AXIS (DISTANCE         , METERS  )                 -  CONCENTRATION  -
       ------------------------------------------------------------------------------------------------------------------

    3000.000      .011132     .010718     .010313     .009825     .009274     .008676     .007960     .007140     .005815
    2000.000      .023277     .021920     .020440     .018649     .016675     .014743     .012669     .010775     .007884
    1500.000      .039435     .036255     .032519     .028143     .023800     .020174     .016174     .013332     .012929
    1250.000      .055109     .049623     .042936     .035199     .029058     .023578     .018666     .018258     .016407
    1000.000      .083024     .072289     .059138     .045782     .035410     .028291     .027081     .025226     .020484
     800.000      .126387     .104976     .077414     .056716     .042971     .040443     .036643     .032047     .026113
     600.000      .217762     .165655     .108529     .074463     .066224     .058441     .048326     .044038     .033999
     400.000      .467843     .296279     .164865     .131019     .102854     .092866     .074963     .061299     .042325
     200.000     1.648651     .647888     .369765     .280463     .196432     .143784     .104532     .079405     .050566
        .000      .000000    3.983659    1.105991     .519474     .305785     .202933     .136970     .099203     .059605
    -200.000     2.102750     .987274     .518289     .343565     .227503     .161521     .114872     .085972     .053735
    -400.000      .646170     .453522     .265170     .193219     .146355     .124111     .092561     .072742     .047995
    -600.000      .315837     .250973     .171062     .122966     .100846     .085959     .069277     .059842     .041825
    -800.000      .189593     .162225     .121072     .092402     .072393     .063458     .055065     .046934     .035871
   -1000.000      .127975     .113872     .093977     .074128     .059224     .048441     .043014     .038539     .029989
   -1250.000      .087773     .080191     .069332     .056940     .048164     .040056     .032451     .029669     .025003
   -1500.000      .064444     .059852     .053448     .046148     .039346     .034007     .027947     .023461     .020625
   -2000.000      .039547     .037442     .034658     .031422     .027930     .024794     .021679     .018763     .014140
```

FIGURE 4-6. Example listing of seasonal ground-level concentration for the fall season due to a single source with a maximum 10 table showing the contribution of this source to the maximum 10 receptors of the indicated combined sources.

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**** ISCLT *************                     HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE    53 ****

        ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER             ) DUE TO SOURCE     2 (CONT ) **
                                                           SEASON  4
                                                   - GRID SYSTEM RECEPTORS -
                                                 - X AXIS (DISTANCE, METERS) -
                        000      200.000      400.000      600.000      800.000     1000.000     1250.000     1500 000     2000 000
Y AXIS (DISTANCE       , METERS  )                               -  CONCENTRATION  -
         ----------------------------------------------------------------------------------------------------------------------

    -3000 000       .019990      .019278      .018395      .017387      .016285      .015118      .013770      .012386      .010297

                                                   - GRID SYSTEM RECEPTORS -
                                                 - X AXIS (DISTANCE, METERS) -
                   3000 000
Y AXIS (DISTANCE       , METERS  )                               -  CONCENTRATION  -
         ----------------------------------------------------------------------------------------------------------------------

     3000 000       .003792
     2000 000       .007452
     1500 000       .010115
     1250.000       .011963
     1000 000       .015308
      800.000       .018061
      600 000       .020866
      400.000       .023662
      200.000       .026373
          000       .029396
     -200 000       .027492
     -400 000       .025712
     -600 000       .023777
     -800 000       .021755
    -1000 000       .019693
    -1250.000       .017154
    -1500 000       .015007
    -2000 000       .011721
    -3000 000       .006980
        ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER             ) DUE TO SOURCE     2 (CONT ) **
                                                          SEASON  4
                                                   - DISCRETE RECEPTORS -
   X          Y         CONCENTRATION        X          Y         CONCENTRATION        X          Y         CONCENTRATION
 RANGE     AZIMUTH                         RANGE     AZIMUTH                         RANGE     AZIMUTH
           BEARING                                   BEARING                                   BEARING
(METERS) (DEGREES)                        (METERS) (DEGREES)                        (METERS) (DEGREES)
         ----------------------------------------------------------------------------------------------------------------------

  2108 0       14.0        .018810
```

FIGURE 4-6. (Continued)

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**** ISCLT *************              HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE     54 ****

      ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER          ) DUE TO SOURCE      2 (CONT.)  **
                                                 SEASON  4
               - 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF COMBINED SOURCES      2,    -11,

                                  X            Y        CONCENTRATION
                              COORDINATE   COORDINATE

                               (METERS)     (METERS )
                              -------------------------------------
                                 200.00          .00        3.983659
                                -200.00          .00        2.440995
                                    .00      -200.00        2.102750
                                    .00       200.00        1.648651
                                 400.00          .00        1.105991
                                 200.00      -200.00         .987274
                                -200.00       200.00         .979780
                                 200.00       200.00         .647888
                                -400.00          .00         .766300
                                 600.00          .00         .519474
```

FIGURE 4-6. (Continued)

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**** ISCLT *************                    HYPOTHETICAL POTASH PROCESSING PLANT                        ********* PAGE    193 ****

 ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER              )       FROM COMBINED SOURCES      2.   -11.
                                                   SEASON  1
                                          - GRID SYSTEM RECEPTORS -
                                        - X AXIS (DISTANCE, METERS) -
               -3000.000    -2000.000    -1500.000    -1250.000    -1000.000     -800.000     -600.000     -400.000     -200.000
Y AXIS (DISTANCE      , METERS  )                        -  CONCENTRATION  -
          ---------------------------------------------------------------------------------------------------------------------

  3000.000       .064939      .081815      .090442      .093946      .090860      .103081      .106639      .109379      .111157
  2000.000       .106435      .130257      .154140      .160670      .182109      .192631      .204155      .216342      .224829
  1500.000       .133526      .187896      .214016      .235257      .267735      .292967      .317284      .343468      .360132
  1250.000       .149919      .223726      .271791      .292988      .329242      .372322      .412979      .454770      .498940
  1000.000       .158608      .263556      .343058      .388532      .430137      .478582      .557523      .634555      .714442
   800.000       .165390      .297984      .408441      .482579      .565467      .628806      .719469      .864366     1.014220
   600.000       .171142      .319244      .481266      .589643      .733854      .873284     1.023637     1.241259     1.596157
   400.000       .175621      .336467      .524223      .685162      .935265     1.187631     1.562860     2.033065     2.681197
   200.000       .178629      .347989      .554271      .739324     1.041162     1.457743     2.216563     3.777196     5.935093
      .000       .182407      .359525      .580160      .782611     1.121842     1.610345     2.557164     4.735265    11.875166
  -200.000       .168291      .318140      .492181      .641604      .873315     1.172356     1.663902     2.508706     3.755635
  -400.000       .156434      .282235      .414114      .515518      .653584      .776860     1.018566     1.332094     2.522483
  -600.000       .143768      .244061      .333389      .388428      .484526      .578024      .683933     1.079533     1.923621
  -800.000       .130615      .205676      .270860      .321324      .378608      .425724      .599228      .904494     1.374565
 -1000.000       .117294      .175390      .229886      .262029      .293920      .388997      .547636      .759141     1.014581
 -1250.000       .101574      .150537      .184855      .201877      .272781      .360828      .468114      .618119      .741997
 -1500.000       .089586      .127973      .148506      .191081      .257228      .321642      .401522      .490660      .566689
 -2000.000       .072628      .091397      .139342      .173474      .213293      .252385      .293381      .330088      .363500
 -3000.000       .046237      .083204      .110136      .125542      .143738      .156438      .168728      .180281      .190756

                                          - GRID SYSTEM RECEPTORS -
                                        - X AXIS (DISTANCE, METERS) -
                    000      200.000      400.000      600.000      800.000     1000.000     1250.000     1500.000     2000.000
Y AXIS (DISTANCE      , METERS  )                        -  CONCENTRATION  -
          ---------------------------------------------------------------------------------------------------------------------

  3000.000       .111952      .109206      .104955      .099860      .094133      .087930      .079972      .073523      .063042
  2000.000       .229038      .220673      .206241      .188658      .169062      .151487      .135083      .119100      .091672
  1500.000       .380951      .362379      .327661      .285330      .246537      .217032      .182159      .153192      .156945
  1250.000       .524333      .493427      .432899      .366990      .309490      .262351      .212829      .215456      .203137
  1000.000       .771359      .713399      .595707      .479549      .391676      .318745      .318693      .307152      .258038
   800.000      1.139485     1.028829      .814949      .614054      .476670      .460593      .444352      .398503      .329583
   600.000      1.862829     1.608295     1.126707      .806090      .761112      .703600      .601132      .545856      .436228
   400.000      3.595022     2.899255     1.684776     1.476967     1.240294     1.102782      .944229      .784874      .549824
   200.000      9.756812     5.556996     3.856307     3.346937     2.446834     1.831592     1.349613     1.033316      .662660
      .000       .000000    31.930078    12.969607     6.628650     3.994073     2.668362     1.806482     1.311342      .788890
  -200.000     11.878918     9.135990     6.359089     4.656605     3.064423     2.180199     1.548060     1.157483      .721220
  -400.000      4.986083     4.801398     3.206142     2.591872     2.045873     1.694547     1.281265     1.001035      .654611
  -600.000      2.744623     2.684374     2.090629     1.606659     1.389698     1.206665      .984949      .842692      .580495
  -800.000      1.742541     1.741282     1.489770     1.195214      .974189      .883146      .778215      .668289      .510518
 -1000.000      1.211973     1.220247     1.074359      .921937      .786617      .662942      .604461      .546487      .428215
 -1250.000       .848989      .857030      .782491      .699415      .612264      .536000      .449388      .418619      .356182
 -1500.000       .631079      .637160      .594914      .537212      .483866      .437785      .379092      .327110      .293155
 -2000.000       .392258      .395542      .378251      .354842      .326906      .302093      .276057      .248939      .199012
```

FIGURE 4-7. Example listing of seasonal ground-level concentration for the winter season from combined sources.

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**** ISCLT *************                 HYPOTHETICAL POTASH PROCESSING PLANT                              ******** PAGE    194 ****

 ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER             ) (CONT.) FROM COMBINED SOURCES      2,    -11,
                                                             SEASON  1
                                                    - GRID SYSTEM RECEPTORS -
                                                  - X AXIS (DISTANCE, METERS) -
                    .000       200.000       400.000       600.000       800.000      1000.000      1250.000      1500.000      2000.000
Y AXIS (DISTANCE        , METERS  )                           -  CONCENTRATION  -
           -------------------------------------------------------------------------------------------------------------------------

   -3000 000        .200044       .201306       .196351       .189764       .181872       .172899       .161055       .151201       .133385

                                                    - GRID SYSTEM RECEPTORS -
                                                  - X AXIS (DISTANCE, METERS) -
                 3000.000
Y AXIS (DISTANCE        , METERS  )                           -  CONCENTRATION  -
           -------------------------------------------------------------------------------------------------------------------------

    3000 000        .044778
    2000 000        .092869
    1500 000        .128675
    1250 000        .150842
    1000 000        .197223
     800 000        .234459
     600 000        .272498
     400 000        .310465
     200 000        .347360
         000        .389162
    -200 000        .367450
    -400 000        .347265
    -600 000        .324709
    -800 000        .300586
   -1000 000        .275624
   -1250 000        .242116
   -1500 000        .214588
   -2000 000        .167526
   -3000 000        .099329
 ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER             ) (CONT.) FROM COMBINED SOURCES      2,    -11,
                                                             SEASON  1
                                                      - DISCRETE RECEPTORS -
    X            Y       CONCENTRATION           X           Y       CONCENTRATION            X           Y       CONCENTRATION
  RANGE      AZIMUTH                           RANGE     AZIMUTH                            RANGE     AZIMUTH
             BEARING                                     BEARING                                      BEARING
 (METERS)   (DEGREES)                         (METERS)  (DEGREES)                          (METERS)  (DEGREES)
           -------------------------------------------------------------------------------------------------------------------------

   2108 0       14 0        .190127
```

FIGURE 4-7. (Continued)

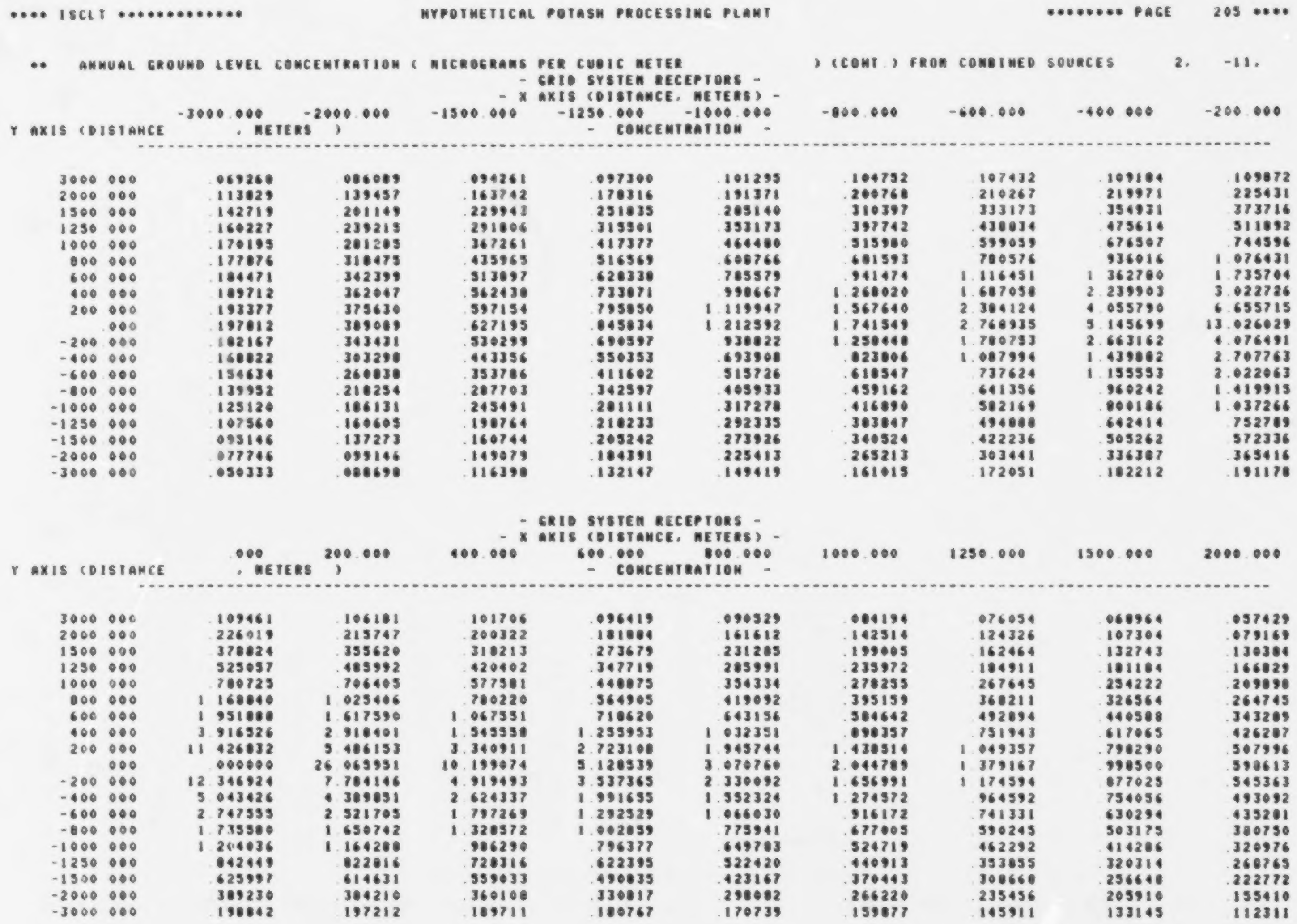
```
**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                         ********* PAGE    195 ****

 ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER          ) (CONT.) FROM COMBINED SOURCES      2,    -11,
                                                  SEASON  1
                                     - PROGRAM DETERMINED MAXIMUM 10 VALUES -

                                         X           Y        CONCENTRATION
                                    COORDINATE  COORDINATE

                                     (METERS)    (METERS )
                                    ----------------------------------------
                                        200.00         .00       31.930078
                                        400.00         .00       12.969607
                                           .00     -200.00       11.878918
                                       -200.00         .00       11.875166
                                           .00      200.00        9.756012
                                        200.00     -200.00        9.135990
                                        600.00         .00        6.628650
                                        400.00     -200.00        6.359089
                                       -200.00      200.00        5.935093
                                        200.00      200.00        5.556996
```

FIGURE 4-7. (Continued)



```
**** ISCLT *************                    HYPOTHETICAL POTASH PROCESSING PLANT                                 ********* PAGE    205 ****

  **    ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER              ) (CONT.) FROM COMBINED SOURCES      2.    -11.
                                                             - GRID SYSTEM RECEPTORS -
                                                           - X AXIS (DISTANCE, METERS) -
                  -3000.000    -2000.000    -1500.000    -1250.000    -1000.000     -800.000     -600.000     -400.000     -200.000
Y AXIS (DISTANCE          , METERS  )                             -  CONCENTRATION  -
              -----------------------------------------------------------------------------------------------------------------

     3000.000       .069268      .086089      .094261      .097300      .101295      .104752      .107432      .109184      .109872
     2000.000       .113829      .139457      .163742      .178316      .191371      .200768      .210267      .219971      .225431
     1500.000       .142719      .201149      .229943      .251835      .285140      .310397      .333173      .354931      .373716
     1250.000       .160227      .239215      .291806      .315501      .353173      .397742      .438034      .475614      .511892
     1000.000       .170195      .281285      .367261      .417377      .464480      .515980      .599059      .676507      .744596
      800.000       .177876      .318475      .435965      .516569      .608766      .681593      .780576      .936016     1.076431
      600.000       .184471      .342399      .513897      .628330      .785579      .941474     1.116451     1.362780     1.735704
      400.000       .189712      .362047      .562438      .733871      .990667     1.268020     1.687058     2.239903     3.022726
      200.000       .193377      .375630      .597154      .795850     1.119947     1.567640     2.384124     4.055790     6.655715
         .000       .197812      .389089      .627195      .845834     1.212592     1.741549     2.768935     5.145699    13.026029
     -200.000       .182167      .343431      .530299      .690597      .938022     1.250448     1.780753     2.663162     4.076491
     -400.000       .168822      .303298      .443356      .550353      .693908      .823806     1.087994     1.439882     2.707763
     -600.000       .154634      .260838      .353786      .411602      .515726      .618547      .737624     1.155553     2.022063
     -800.000       .139952      .218254      .287703      .342597      .405933      .459162      .641356      .960242     1.419915
    -1000.000       .125120      .186131      .245491      .281111      .317278      .416890      .582169      .800186     1.037266
    -1250.000       .107560      .160605      .198764      .218233      .292335      .383847      .494088      .642414      .752789
    -1500.000       .095146      .137273      .160744      .205242      .273926      .340524      .422236      .505262      .572336
    -2000.000       .077746      .099146      .149079      .184391      .225413      .265213      .303441      .336387      .365416
    -3000.000       .050333      .088698      .116398      .132147      .149419      .161015      .172051      .182212      .191178

                                                             - GRID SYSTEM RECEPTORS -
                                                           - X AXIS (DISTANCE, METERS) -
                       .000      200.000      400.000      600.000      800.000     1000.000     1250.000     1500.000     2000.000
Y AXIS (DISTANCE          , METERS  )                             -  CONCENTRATION  -
              -----------------------------------------------------------------------------------------------------------------

     3000.000       .109461      .106181      .101706      .096419      .090529      .084194      .076054      .068964      .057429
     2000.000       .226019      .215747      .200322      .181804      .161612      .142514      .124326      .107304      .079169
     1500.000       .378824      .355620      .318213      .273679      .231285      .199005      .162464      .132743      .130384
     1250.000       .525057      .485992      .420402      .347719      .285991      .235972      .184911      .181184      .166829
     1000.000       .780725      .706405      .577581      .440875      .354334      .278255      .267645      .254222      .209898
      800.000      1.168840     1.025406      .780220      .564905      .419092      .395159      .368211      .326564      .264745
      600.000      1.951888     1.617590     1.067551      .710620      .643156      .584642      .492894      .440508      .343289
      400.000      3.916526     2.918401     1.545558     1.255953     1.032351      .898357      .751943      .617065      .426287
      200.000     11.426832     5.486153     3.340911     2.723108     1.945744     1.438514     1.049357      .798290      .507996
         .000       .000000    26.065951    10.199074     5.128539     3.070760     2.044789     1.379167      .998500      .598613
     -200.000     12.346924     7.784146     4.919493     3.537365     2.330092     1.656991     1.174594      .877025      .545363
     -400.000      5.043426     4.389851     2.624337     1.991655     1.552324     1.274572      .964592      .754056      .493092
     -600.000      2.747555     2.521705     1.797269     1.292529     1.066030      .916172      .741331      .630294      .435281
     -800.000      1.735580     1.650742     1.320572     1.002859      .775941      .677005      .590245      .503175      .380750
    -1000.000      1.204036     1.164288      .986290      .796377      .649783      .524719      .462292      .414286      .320976
    -1250.000       .842449      .822016      .728316      .622395      .522420      .440913      .353855      .320314      .268765
    -1500.000       .625997      .614631      .559033      .490835      .423167      .370443      .308660      .256648      .222772
    -2000.000       .389230      .384210      .360108      .330817      .298082      .266220      .235456      .205910      .155410
    -3000.000       .198842      .197212      .189711      .180767      .170739      .159877      .145911      .133145      .112311
```

FIGURE 4-8. Example listing of annual ground-level concentration from combined sources.

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**** ISCLT *************                    HYPOTHETICAL POTASH PROCESSING PLANT                                   ******** PAGE    206 ****

 **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER            ) (CONT.) FROM COMBINED SOURCES      2.    -11.
                                                   - GRID SYSTEM RECEPTORS -
                                                - X AXIS (DISTANCE, METERS) -
                    3000.000
Y AXIS (DISTANCE       , METERS  )                   -  CONCENTRATION  -
          --------------------------------------------------------------------------------------------------------------

   3000.000         .030590
   2000.000         .076173
   1500.000         .104005
   1250.000         .121078
   1000.000         .155257
    800.000         .182486
    600.000         .210169
    400.000         .237654
    200.000         .264195
       .000         .294133
   -200.000         .277120
   -400.000         .261307
   -600.000         .243727
   -800.000         .224994
  -1000.000         .205666
  -1250.000         .180084
  -1500.000         .160324
  -2000.000         .126348
  -3000.000         .077164
 **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER            ) (CONT.) FROM COMBINED SOURCES      2.    -11.
                                                   - DISCRETE RECEPTORS -
    X         Y        CONCENTRATION          X          Y       CONCENTRATION           X          Y       CONCENTRATION
 RANGE     AZIMUTH                          RANGE     AZIMUTH                          RANGE     AZIMUTH
           BEARING                                    BEARING                                    BEARING
 (METERS) (DEGREES)                        (METERS) (DEGREES)                         (METERS) (DEGREES)
        ----------------------------------------------------------------------------------------------------------------

  2108.0       14.0        .183942
                                                - PROGRAM DETERMINED MAXIMUM 10 VALUES -

                                                   X               Y          CONCENTRATION
                                               COORDINATE     COORDINATE


                                                (METERS)       (METERS )
                                               ------------------------------------------
                                                   200.00            .00        26.065951
                                                  -200.00            .00        13.026029
                                                      .00        -200.00        12.346924
                                                      .00         200.00        11.426832
                                                   400.00            .00        10.199074
                                                   200.00        -200.00         7.784146
                                                  -200.00         200.00         6.655715
                                                   200.00         200.00         5.486153
```

FIGURE 4-8. (Continued)

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**** ISCLT *************                  HYPOTHETICAL POTASH PROCESSING PLANT                          ******** PAGE    207 ****

 **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER            ) (CONT. ) FROM COMBINED SOURCES      2,    -11,
                                          - PROGRAM DETERMINED MAXIMUM 10 VALUES -

                                               X           Y         CONCENTRATION
                                          COORDINATE   COORDINATE

                                            (METERS)    (METERS )
                                          ----------------------------------------
                                             -400.00          .00         5.145699
                                              600.00          .00         5.128539
```

FIGURE 4-8. (Continued)

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**** ISCLT *************                HYPOTHETICAL POTASH PROCESSING PLANT                                ******** PAGE    316 ****

      ** SEASONAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER             ) DUE TO SOURCE      4 (CONT.) **
                                                        SEASON  4
             - 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF COMBINED SOURCES    -16.

                                       X            Y         CONCENTRATION
                                  COORDINATE   COORDINATE


                                   (METERS)     (METERS )
                                  -------------------------------------
                                     200.00          .00        4.493998
                                    -200.00          .00        2.054139
                                        .00      -200.00        1.823837
                                        .00       200.00        1.551934
                                    -200.00       200.00         .899412
                                     400.00          .00        1.244917
                                    -400.00          .00         .717025
                                     200.00      -200.00        1.014321
                                        .00      -400.00         .617223
                                    -200.00      -200.00         .581724
```

FIGURE 4-9. Example listing of the 10 values of seasonal ground-level concentration from a single source that contribute to the maximum 10 receptors of the indicated combined sources for the fall season.

```
**** ISCLT *************                 HYPOTHETICAL POTASH PROCESSING PLANT                    ******** PAGE    317 ****

   **    ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER             ) DUE TO SOURCE      4 (CONT.)  **
             - 10 CONTRIBUTING VALUES TO PROGRAM DETERMINED MAXIMUM 10 OF COMBINED SOURCES    -16.

                                    X            Y           CONCENTRATION
                               COORDINATE   COORDINATE

                                (METERS)     (METERS )
                              ----------------------------------------
                                  200.00          .00         4.343051
                                 -200.00          .00         1.806942
                                     .00      -200.00         1.812556
                                     .00       200.00         1.478618
                                 -200.00       200.00          .828512
                                  400.00          .00         1.186533
                                  200.00      -200.00         1.044206
                                 -400.00          .00          .626691
                                     .00      -400.00          .617730
                                 -200.00      -200.00          .524317
```

FIGURE 4-10. Example listing of the 10 values of annual ground-level concentration for a single source that contribute to the maximum 10 receptors of the indicated combined sources.

with the program output format before using it. Also, the program has the option (ISW(17)) of specifying the number of lines the printer prints per page. This value must be correct in order for the program to maintain a correct output format. The program defaults to 57 lines per printed page. If the printer at your installation is different, input the correct value into ISW(17) on Card Group 2. The warning and error messages produced by the program are generated by data errors within the ISCLT program and are not associated with errors detected by the computer system on which the program is being run. These errors are given in Section 4.2.6 below.

b. Master Tape Inventory Output. The ISCLT program will, on option, generate an output master source/concentration or deposition inventory tape or data file. This file may be a permanent file or a temporary file, depending on what the user desires and requirements of the program. This data tape is written only if the parameter ISW(5) equals "1" or "3" and the data are written to the FORTRAN logical unit specified by ISW(15). The data are written using the FORTRAN binary write routines and tapes should be assigned high density, odd parity with the write-ring in. These assign options are normally the default options on nine-track tape units, except for the write-ring option. These tapes are not transferable between computers of a different manufacturer and may not be transferable between computers of a different series and same manufacturer. Also, if the ISCLT program has been compiled under the UNIVAC FORTRAN V compiler, tapes generated by the program are not compatible with the ISCLT program compiled under the UNIVAC ASCII compiler and vice versa. Check with your installation to see if these FORTRAN generated binary tapes can be transferred. The format and contents of the ISCLT input/output tape are shown in Table 4-5. This table gives the Logical Record, Word Number, Parameter Name and whether the data are in an integer or floating point (real) format. The logical record gives the order the respective data records are written to tape and does not imply the physical (block) length actually on the tape. The physical block length of binary unformatted data depends on the computer (FORTRAN) on which the ISCLT program

TABLE 4-5

INPUT/OUTPUT TAPE FORMAT

Tape Logical Record	Relative Word Number	Parameter Name	Integer (I)/ Floating Point (FP)
1	1	NSOURC	I
	2	NXPNTS	I
	3	NYPNTS	I
	4	NXWYPT	I
	5	NSEASN	I
	6	NSPEED	I
	7	NSTBLE	I
	8	NSCTOR	I
	9 - 28	ISW	I
	29 - 48	UNITS	I
	49 - 68	TITLE	I
2	1 - NXPNTS+NXWYPT	X	FP
3	1 - NYPNTS+NXWYPT	Y	FP
4*	1 - NXPNTS*NYPNTS +NXWYPT	Z	FP
5	1 - 2304	FREQ	FP
	2305 - 2328	TA	FP
	2329 - 2472	HM	FP
	2473 - 2508	DPDZ	FP
	2509 - 2514	UBAR	FP

*Tape logical record 4 is on the tape only if the parameter ISW(4) equals one.

TABLE 4-5 (Continued)

Tape Logical Record	Relative Word Number	Parameter Name	Integer (I)/ Floating Point (FP)
5 (Cont.)	2515 - 2550	P	FP
	2551 - 2566	THETA	FP
	2567	ROTATE	FP
	2568	G	FP
	2569	ZR	FP
	2570	BETA1	FP
	2571	BETA2	FP
	2572	DECAY	FP
	2573	TK	FP
6**	1	NUMS	I
	2	TYPE	I
	3	DX	FP
	4	DY	FP
	5	H	FP
	6	ZS	FP
	7	TS	FP
	8	VEL	FP
	9	D	FP
	10	HB	FP
	11	BW	FP
	12	BL	FP
	13	NVS	I
	14 - 33	VS	FP
	34 - 53	FRQ	FP

**Records 6 through 10 are repeated for each source input to the program.

TABLE 4-5 (Continued)

Tape Logical Record	Relative Word Number	Parameter Name	Integer (I)/ Floating Point (FP)
6** (Cont.)	54 - 73	GAMMA	FP
	74 - 217	Q	FP
	218	QFLG	I
	219	WAKE	I
7**	1 - NXPNTS*NYPNTS +NXWYPT	CON	FP
8**	1 - NXPNTS*NYPNTS +NXWYPT	CON	FP
9**	1 - NXPNTS*NYPNTS +NXWYPT	CON	FP
10**	1 - NXPNTS*NYPNTS +NXWYPT	CON	FP
⋮	⋮	⋮	⋮
last	1	999999	I

**Records 6 through 10 are repeated for each source input to the program and 8 through 10 are omitted if the input data is annual.

is being run. The maximum physical block length on UNIVAC 1100 series computers is 224 words per block. Some of the logical records shown in Table 4-5 may or may not be present on the tape, depending on the options ISW(4) and NSEASN. Logical record 4 is not on the tape if the parameter ISW(4) is zero. Also, records 7 through 10 are concentration or deposition records and depend on the number of seasons, NSEASN. If the user is using annual data, only record 7 out of records 7 through 10 will be on the tape. Records 6 through 10 are written to the tape for each source input to the program. The last record written for a program run has an integer 999999 in word 1 (NUMS) of the record and two end of file marks (magnetic tape only) are written after this record. The program does not check these tapes for labels, nor does it write a leading label file on the tape. Also, if you desire to write more than one data case (run) to an output tape, make sure the tape is positioned between the two end of file marks after the last case written to the tape. See Section 4.2.2 for the correct tape or data file assign cards.

4.2.5 Program Run Time, Page and Tape Output Estimates

This section gives approximations to the computer run time, tape output and page output for the ISCLT program. Because of the variability of problem runs and input parameters, the equations in this section are meant only to give an approximation of the upper limit of the time, page or tape usage function.

a. Run Time. The total run time required for a problem run using card input sources is given by

$$\text{Time (Seconds)} \cong \Big(N_s \cdot \big(N_x \cdot N_y + N_{xy}\big) \cdot N_{se} \cdot N_{st} \cdot N_{sp} \cdot \big(N_{vs} + 1\big) \cdot f\Big) \geq 120 \qquad (4\text{-}6)$$

where

N_s = the total number of sources from card for which concentration (deposition) calculations are to be made, NSOURC

N_x = the total number of points in the grid system X-axis, NXPNTS

N_y = the total number of points in the grid system Y-axis, NYPNTS

N_{xy} = the total number of discrete (arbitrarily placed) points NXWYPT

N_{se} = the number of seasons, NSEASN

N_{st} = the number of stability categories, NSTBLE

N_{sp} = the number of wind speed categories, NSPEED

N_{vs} = the maximum number of particulate categories for any source if deposition or concentration with depletion due to deposition is being calculated; otherwise N_{vs} is zero

$$f = \begin{cases} 6 \times 10^{-4}; & \text{for concentration calculations} \\ 7 \times 10^{-4}; & \text{for deposition or concentration with depletion due to deposition} \end{cases}$$

The variable f given above was calculated from example runs on a UNIVAC 1108 computer. If you are using a different computer or if the values of f given here are not accurate for your runs, recalculate f and replace it with a more representative value. If N_s in Equation (4-6) is zero (all sources from tape), use the following equation to approximate the time:

$$\text{Time (seconds)} \cong \left(N'_s \cdot \left(N_x \cdot N_y + N_{xy}\right) \cdot N_{se} \cdot N_g \cdot k\right) \geq 120 \quad (4\text{-}7)$$

where

N'_s = total number of input sources from tape or data file

N_g = number of source combinations to be printed, NGROUP

$k \cong 4 \times 10^{-3}$

The variable k is an approximation from a few example runs and the user may want to substitute a value that works better on his/her computer. Also, if the system on which the user is running this program aborts runs (jobs) that max-time, be generous with the time estimate.

b. Page Output. The total number of pages of output from the long-term ISCLT program depends on the problem being run and is given by:

$$\text{Pages} \cong \underline{A} + \underline{B} + \underline{C} \qquad (4\text{-}8)$$

where*

$$\underline{A} = \begin{cases} 0\ ; & \text{if the program input data is not printed} \\ 16\ ; & \text{if input data other than source data is printed (ISW(6) = "1")} \\ N_s\ ; & \text{if source data only is printed (ISW(6) = "2")} \\ 16 + N_s; & \text{if all input data is printed (ISW(6) = "3") and (ISW(4) = "0"), no terrain data} \\ 16 + N_s + \left\lceil \dfrac{N_x}{9} \right\rceil \cdot \left\lceil \dfrac{N_y}{(N_\ell - 19)} \right\rceil + \left\lceil \dfrac{N_{xy}}{3\ (N_\ell - 11)} \right\rceil; & \text{if all input data is printed (ISW(6) = "3") and (ISW(4) = "1") terrain data are used} \end{cases} \qquad (4\text{-}9)$$

N_s = total number of sources input to the program. However, if concentration or deposition from individual sources is not being printed (ISW(8) = "2") use $N_s = \lceil N_s/4 \rceil$

---

*The ⌈ ⌉ symbols indicate to round up to the next largest integer if there is any fractional part.

N_ℓ = Number of print lines per page (ISW(17)), default is 57.

$$\underline{B} \cong I \cdot \left(N_i + N_c\right) \cdot \left(\left[\frac{\frac{N_x}{9} \cdot (N_y + 11)}{N_\ell} \right] + \left[\frac{N_{xy}}{3 \cdot (N_\ell - 11)} \right] + K \right) \qquad (4\text{-}10)$$

I = number of seasons for which concentration or deposition is to be printed. If seasonal output only, then I = NSEASN; if annual output only, then I = 1; if both seasonal and annual output, then I = NSEASN+1.

N_i = total number of individual source concentration or deposition tables being printed. If ISW(8) equals "2", then N_i is set to zero. If ISW(8) equals "1" or "3", then N_i is the total number of source ID-numbers defined under the parameter IDSORC. This includes both implied and explicily punched source ID-numbers in IDSORC. Count each source ID-number only once. If the parameter NGROUP is "0" and the array IDSORC is not input, then N_i is the total number of card plus tape input sources. Also, if maximum 10 calculations are being made via ISW(11) or ISW(12), add N_i pages to the total pages in Equation (4-8) above for the individual source contributions to the combined maximum 10.

N_c = total number of combined source concentration or deposition tables being printed (NGROUP). Do not count single sources if they are already counted in N_i.

N_x = NXPNTS

N_y = NYPNTS

N_{xy} = NXWYPT

$$K = \begin{cases} 0; & \text{if maximum 10 values are not printed (ISW(10) = 0)} \\ 1; & \text{if maximum 10 values are printed (ISW(10) > 0)} \end{cases}$$

C $\cong$ the number of pages expected from the system plus other processing within the job

The above equations may not cover every option in the ISCLT program and, if the system the user is using aborts runs that max-page, be generous with the page approximation.

c. Tape Output. The total amount of tape used by a problem run depends on the type of computer, the installation standard block length for unformatted FORTRAN records, the number of tape recording tracks, the tape recording density and the options and data input to the problem run. This section provides the user with the total number of computer words output to tape or data file and an approximation to the tape length used in feet.

The total number of computer words output to tape is given by

$$\text{Words} = \Big(I + 2645 + N_x + N_y + 2N_{xy} + N_s\big(220 + N_{se}(N_x \cdot N_y + N_{xy} + 1)\big)\Big) \qquad (4\text{-}11)$$

where

$$I = \begin{cases} 0 & ; \text{ if option ISW(4)} = 0 \\ N_x \cdot N_y + N_{xy} + 1 & ; \text{ if option ISW(4)} = 1 \end{cases}$$

N_s = the total number of card and/or tape input sources

N_{se} = the number of seasons, NSEASN

N_x = NXPNTS

N_y = NYPNTS

N_{xy} = NXWYPT

Add 28 to the total number of words written for UNIVAC 1100 series computers.

The user can approximate the length of tape required by

$$\text{Length (feet)} \simeq \left[\left(\frac{\text{Words} \cdot B}{B_y \cdot D}\right) + 0.75\left(\frac{\text{Words}}{B\ell}\right) + 6.0\right] \Big/ 12.0 \qquad (4\text{-}12)$$

where

B = the number of bits per computer word. IBM 360, etc. is 32, UNIVAC 1100 series is 36 and CDC 6000 series is 60.

D = the tape recording density choosen by the user or required by the I/O device, 200, 556, 800 or 1600 bpi.

$B\ell$ = the number of words per physical tape block for unformatted FORTRAN records on the user's computer system. Use 224 for UNIVAC 1100 series computers.

B_y = "6" for 7 track tape or "8" for 9 track tape

The values 0.75 and 6.0 inches are used assuming the interrecord gap is 0.75 and the end-of-file is 6 inches.

4.2.6 Program Diagnostic Messages

The diagnostic messages produced by the ISCLT program are associated only with data and processing errors within the program and should not be confused with those produced by the computer system on which the ISCLT program is run. All messages begin with either the word ERROR or the word WARNING. All ERROR messages terminate the execution of the program and WARNING messages allow the program to continue. However, WARNING messages could indicate data errors and should be examined thoroughly when they occur. A list of the messages are given in Table 4-6 with the probable cause of the respective message.

TABLE 4-6

ISCLT WARNING AND ERROR MESSAGES

1. ERROR - MAX STORAGE = n, USER REQUESTED m REDUCE NO. OF CALC. POINTS. The program execution is terminated because the run required n locations of BLANK COMMON and only m are available. See Equation (4-1) in Section 4.1.2 for the core usage equation. See, also, Equations (4-2) and (4-3) that may place additional restrictions on the user.

2. ERROR - NUMBER OF SETTLING VELOCITIES FOR SOURCE n IS ZERO. Deposition is being calculated and the parameter NVS on Card Group 17 is zero for source n. Set NVS to the number of settling velocity categories and rerun.

3. WARNING - FREQ. OF OCCURRENCE OF SPD VS. DIR IS NOT 1.0 FOR SEASON n, PROG DIVIDES BY xxx.x TO NORMALIZE. The sum over all categories of the joint frequency of occurrence of wind speed and wind direction for season n is not exactly 1.0 and the program normalizes the frequency distribution by the factor xxx.x; execution continues.

4. WARNING - DISTANCE BETWEEN SOURCE n AND POINT X, Y = xx.x, yy.y IS LESS THAN PERMITTED. This is a warning message to inform the user that the program attempted to calculate concentration or deposition at the point xx.x, yy.y for source n, but the distance is less than the model allows and no calculations were made, but execution continues. The user should ignore calculations at xx.x,yy.y for source n or any source combination including source n.

TABLE 4-6 (Continued)

5. ERROR - ELEVATION zzz.z EXCEEDS SOURCE EMISSION ELEVATION FOR SOURCE n, PROG. TERMINATED. If any elevation exceeds a source emission elevation, program execution is terminated.

6. ERROR - DISP CANNOT EQUAL 2 WHEN QFLG IS GREATER THAN 0, OFFENDING SOURCE = n, PROG. TERMINATED. An attempt was made to rescale concentrations that do not vary only by season. The program saves only seasonal concentration on tape and cannot rescale with source strengths that vary by wind speed and/or stability. Input all of the source data via card setting DISP equal to zero and NUMS equal to the respective tape input source ID-number. The tape source will be replaced by the card source.

7. ERROR - DISP GREATER THAN 0 FOR SOURCE n, NO MORE TAPE SOURCES, PROG. TERMINATED. The program has found a source input card (Card Group 17) that indicates it is to update or delete a tape source, but it has run out of tape sources. Check your input source deck and make sure you have the correct input tape.

8. ERROR - DISP GREATER THAN 0 FOR SOURCE n, CANNOT FIND CORRESPONDING TAPE SOURCE, PROG. TERMINATED. The program has found an input source card (Card Group 17) that indicates it is to update or delete source n, but that source is not on the tape. Check the sequence of the input source data as they must be in ascending order of the source ID-number. Also, make sure you have the correct input tape.

TABLE 4-6 (Continued)

9. WARNING - HW/HB > 5 FOR SOURCE n, PROG. USES LATERAL VIRTUAL DIST. FOR UPPER BOUND OF CONCENTRATION (DEPOSITION). The program is informing the user that the supersquat building wake effects option (WAKE) on Card Group 17 was set to blank, "0" and the program defaulted to those equations for the lateral virtual distance that produce the upper bound on the concentration or deposition. The lower bound may be calculated in another run by setting WAKE = 1.

10. ERROR - AVAILABLE CORE = n, PROBLEM REQUIRES m OR MORE LOCATIONS. The program has determined that m locations of BLANK COMMON are required for the run, but only n locations are available. See Equations (4-1), (4-2) and (4-3) in Section 4.1.2.

11. ERROR - MAX. NO. OF SOURCES EXCEEDED FOR NGROUP OF ISW(11) = 2 OPTION. The number of sources the program has input exceeds the number the program is capable of processing under the special condition c, under the parameters NGROUP or ISW(11) = "2". See Equations (4-2) and (4-3) in Section 4.1.2 or Equations (4-4) and (4-5) in Section 4.2.3.

12. ERROR - STACK DIAMETER < = 0 FOR SOURCE n. Stack sources require a stack diameter greater than zero. Check the order of the input source deck.

13. WARNING - EXIT VELOCITY IS < = 0 FOR SOURCE n, PROG. SETS TO 1.0E-5 AND CONTINUES. The program sets a zero exit velocity for stacks to 1.0E-5, because it is used as a divisor in the plume rise equations. If you did not intend to set the exit velocity to zero for no plume rise, check the offending card and the order of the input source deck.

TABLE 4-6 (Continued)

14. ERROR - SIGYO $\leq$ 0 FOR SOURCE n. Volume sources must have SIGYO greater than zero. Check the order of the input source deck.

15. ERROR - SIGZO $\leq$ 0 FOR SOURCE n. Volume sources must have SIGZO greater than zero. Check the order of the input source deck.

16. ERROR - XO $\leq$ 0 FOR SOURCE n. Area sources must have XO greater than ZERO. Check the order of the input source deck.

17. ERROR - SOURCE n LESS IN VALUE THAN LAST SOURCE n READ. Source input deck is out of order or miss punched.

18. ERROR - DISP CODE FOR SOURCE n IS OUT OF RANGE. The parameter DISP must equal 0, 1 or 2. Check card and order of input source deck.

19. ERROR - TYPE CODE FOR SOURCE n IS OUT OF RANGE. The parameter TYPE must equal 0, 1 or 2. Check card and order of source input deck.

19. ERROR - QFLG CODE FOR SOURCE n IS OUT OF RANGE. The parameter QFLG must equal 0, 1, 2 or 3. Check card and order of source input deck.

4.2.7. Program Modifications for Computers other than UNIVAC 1100 Series Computers

The ISCLT program is written in the FORTRAN language and uses the FORTRAN features compatible with standard ANSI FORTRAN. The program can be implemented on most computers that meet the following requirements:

- Must have the equivalent of 65,000 UNIVAC 1110 words of executable core storage
- Must use 32 or more bits per computer word
- Must use 4 or more characters (bytes) per computer word
- Must allow object time dimensioning (FORTRAN)
- Must have a 132 column line printer

The program also assumes the input card device is logical unit 5, the output printer is logical unit 6, the input tape unit is logical unit 2 and the output tape unit is logical unit 3. However, all but unit 5 can be overridden with an alternate unit number by input option. If the user must change unit 5 to an alternate number for the card input device, he must change the variable IUNT in the main program. This variable appears after the input comments section in the FORTRAN listing of the main program.

The user may also adjust the computer core required by the program by reducing or increasing the dimension (size) of BLANK COMMON in the program. This is the first statement in the main program and, if changed, the user must also change the value of the variable IEND in the main program. The variable IEND appears after the input comments section in the main program. Also, the user must change the value of E in Equations (4-1), (4-2), (4-3), (4-4) and (4-5) in the body of this text. Program capabilities can be severly restricted if the size of BLANK COMMON is reduced.

It is not possible to give all changes required to implement this program on all computers. However, changes necessary to implement this program on IBM and CDC medium to large scale computers are given below:

Changes required for use on IBM 360 or above computers:

- Change the call ACOS to ARCOS in subroutine DISTR on the 17th line

Changes required for use on CDC 6000 or above series computers:

- Add the following line on the first line of the main program

  ```
  PROGRAM ISCLT (INPUT, OUTPUT, TAPE nn, TAPE mm)
  ```

  Where TAPEnn and TAPEmm are the names used on the tape REQUEST card and nn and mm are the logical unit numbers used to reference the input and output tapes, respectively. See the CDC FORTRAN Extended Reference Manual for your machine for variations in this card and alterations of this card by the LGO runstream card

- The program uses the END= clause in the read statement for card source input data

  ```
  READ (IUNT, 9023, END = 1120) NUMS1, DISP. etc.
  ```

  If your FORTRAN does not recognize this statement, remove the ",END = 1120" from this statement on line 612 of subroutine MODEL. Also, if this clause is removed from this statement, the user must insure the program never trys to read beyond the last input card source or the program will error off. Also, the END= clause is used in some of the tape read statements at program listing sequence numbers -- S0107820, S0205430, S0205920 and S0205990. If your FORTRAN does not recognize the END= clause, it must be removed from these statements. The removal of the END= clause from these statements will eliminate the capability of the ISCLT program in some cases to position a tape to the correct file via the input parameter NOFILE when multiple passes are required through the tape data. This problem can be overcome by writting the ISCLT output data to a mass-storage file and then copying the mass-storage file to an output tape file when the program has terminated.

- Two successive file marks are written at the end of execution. The program uses the FORTRAN BACKSPACE command to back the output tape back over the last end of file mark written. If your FORTRAN BACKSPACE command does not back over end of file marks, the tape will be left positioned after the second end of file mark at the end of execution. However, if the program must make multiple passes through the tape for the output reports, the tape will be left positioned after the first file mark at the end of the data set. The program will make multiple passes through the data file, if Condition c under ISW(11) or NGROUP does not apply to the run and Condition a was selected (see Section 4.1.2.a).

REFERENCES

Barry, P. J., 1964: Estimation of downwind concentration of airborne effluents discharged in the neighborhood of buildings. AECL Report No. 2043, Atomic Energy of Canada, Ltd., Chalk River, Onterio.

Briggs, G. A., 1971: Some recent analyses of plume rise observations, In Proceedings of the Second International Clean Air Congress, Academic Press, New York.

Briggs, G. A., 1973: Diffusion estimates for small emissions. ATDL Contribution File No. (Draft) 79, Air Resources Atmospheric Turbulence and Diffusion Laboratories, Oak Ridge, Tennessee.

Briggs, G. A., 1975: Plume rise predictions. In Lectures on Air Pollution and Environmental Impact Analysis, American Meteorological Society, Boston, Massachusetts.

Budney, L. J., 1977: Guidelines for air quality maintenance planning and analysis, Volume 10 (revised): Procedures for evaluating air quality impact of new stationary sources. EPA Report No. EPA-450/4-77-001, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Cramer, H. E., et al., 1972: Development of dosage models and concepts. Final Report under Contract DAAD09-67-C-0020(R) with the U. S. Army, Deseret Test Center Report DTC-TR-609, Fort Douglas, Utah.

Dumbauld, R. K. and J. R. Bjorklund, 1975: NASA/MSFC multilayer diffusion models and computer programs -- version 5. NASA Contractor Report No. NASA CR-2631, National Aeronautics and Space Administration, George C. Marshall Space Center, Alabama.

Dumbauld, R. K., J. E. Rafferty and H. E. Cramer, 1976: Dispersion-deposition from aerial spray releases. Preprint Volume for the Third Symposium on Atmospheric Diffusion and Air Quality, American Meteorological Society, Boston, Massachusetts.

Environmental Protection Agency, 1977: User's manual for single source (CRSTER) model. EPA Report No. EPA-450/2-77-013, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Halitsky, J., 1963: Gas diffusion near buildings. ASHRAE Transcript 69, Paper No. 1855, 464-485.

Halitsky, J., 1978: Comment on a stack downwash prediction formula. Atm. Env., 12, 1575-1576.

Holzworth, G. C., 1972: Mixing heights, wind speeds and potential for urban air pollution throughout the contiguous United States. Publication No. AP-101, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Huber, A. H. and W. H. Snyder, 1976: Building wake effects on short stack effluents. Preprint Volume for the Third Symposium on Atmospheric Diffusion and Air Quality, American Meteorological Society, Boston, Massachusetts.

Huber, A. H., 1977: Incorporating building/terrain wake effects on stack effluents. Preprint Volume for the Joint Conference on Applications of Air Pollution Meteorology, American Meteorological Society, Boston, Massachusetts.

McDonald, J. E., 1960: An aid to computation of terminal fall velocities of spheres. J. Met., 17, 463.

National Climatic Center, 1970: Card Deck 144 WBAN Hourly Surface Observations Reference Manual 1970, available from the National Climatic Center, Asheville, North Carolina 27711.

Sherlock, R. H. and F. A. Stalker, 1941: A study of flow phenomena in the wake of smokestacks. Eng. Res. Bull. No. 29, Department of Engineering, University of Michigan, Ann Arbor, Michigan.

Slade, D. H. (ed.), 1968: Meteorology and Atomic Energy. Prepared by Air Resources Laboratories, ESSA, for U. S. Atomic Energy Commission, 445.

Turner, D. B., 1970: Workbook of Atmospheric Dispersion Estimates. PHS Publication No. 999-AP-26, U. S. Department of Health, Education and Welfare, National Air Pollution Control Administration, Cincinnati, Ohio.

Turner, D. B. and A. Busse, 1973: User's guide to the interactive versions of three point source dispersion programs: PTMAX, PTDIS and PTMPT. Draft EPA Report, Meteorology Laboratory, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Vincent, J. A., 1977: Model experiments on the nature of air pollution transport near buildings. Atm. Env., 11(8), 765-774.

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